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TRESPASSERS

BY THE
REV. J. G. WOOD, M.A.
ILLUSTRATED.

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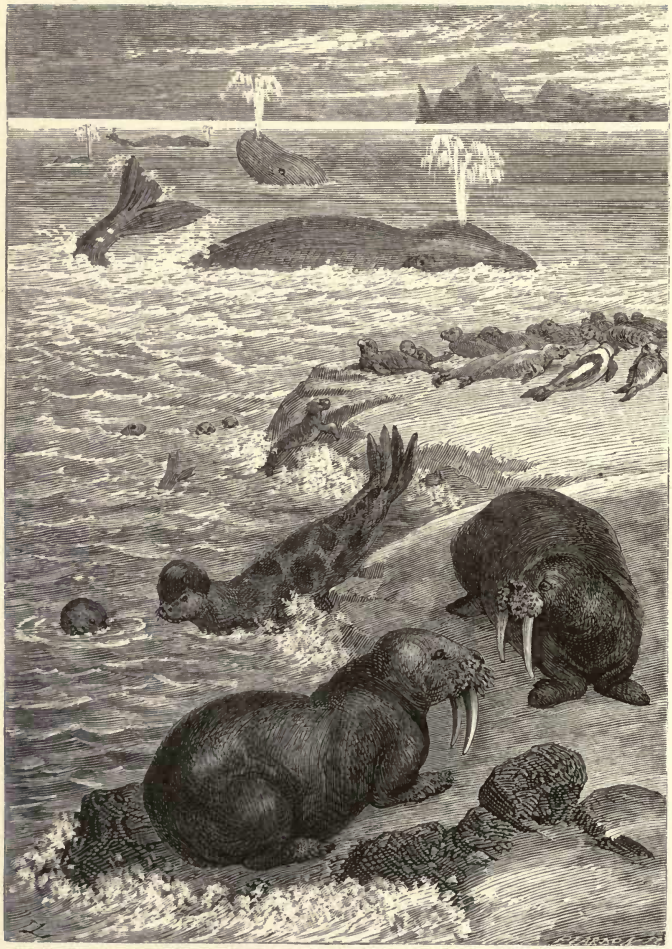

WHALES, SEALS, AND WALRUS.

TRESPASSERS.

SHOWING HOW THE INHABITANTS OF EARTH, AIR, AND WATER ARE ENABLED TO TRESPASS ON DOMAINS NOT THEIR OWN.

BY THE

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"HOMES WITHOUT HANDS,"
ETC. ETC.

WITH NUMEROUS ILLUSTRATIONS.

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PREFACE.

In almost every large group of animal life there is a curious tendency towards usurping the domain which is usually occupied by other groups.

Taking, for example, the Fishes as typical occupiers of the water, we find that there are various groups of Mammalia, Birds, Reptiles, Insects, etc., which live almost as much in the water as do the Fishes themselves. Such, for example, are the Whales and Dolphins among the Mammalia, the Penguins among the Birds, the Turtles, Water Snakes and Newts among the Reptiles, and the Water Beetles among the Insects.

Then, we have the Bats as examples of mammalia which trespass on the domain of the birds; while the Flying Monkey or Colugo, the Flying Squirrels of the Old World, and the Flying Phalangists of Australasia, are examples of partial Trespassers in the same direction. With regard to reptiles (putting aside the extinct Pterodactyls) we have the Flying

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Dragons and the Flying Frog. Even in the fishes and the molluscs we find examples of Trespassers on the domain of air, such as the Flying Fishes, Flying Gurnards, and Flying Squids.

Lastly, we find that some of the fishes, such as the Climbing Perch, and several marine crustacea, such as the Land Crabs, the Robber Crabs, and the Hermit Crabs, are able to leave the water and to trespass on the domain of the mammalia.

It has been my endeavour, in the course of this work, to show how simple, and yet how effectual, are the modifications of structure by which a mammal, ordinarily an inhabitant of earth, is enabled to trespass upon the domains of the Fishes and the Birds —a bird or reptile to trespass upon the realm which belongs to the Fishes, and a fish to trespass upon that of the Mammal.

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TRESPASSERS.

CHAPTER I.

INTRODUCTION.

TRESPASSING seems to exert a strange fascination over most animated beings. There are many, like the sea-anemone and the barnacle, which are fixed to one spot, and cannot trespass even if they wished to do so. In the latter case, however, the creature has led a roving life before it finally settled upon a resting-place, and had every opportunity of gratifying a restless disposition. The very existence of a boundary seems to create a desire to pass it, no matter what may be its nature or extent.

Any one who has seen a goat fastened by a cord, will have remarked that the animal is always at the full extent of the rope. And if its position has not been changed for a day or two, there is always a ring of short grass round the edges of the circle which the goat has described by walking round and round at the extent of its tether. The grass which is near the peg is quite as good as that near the circumference; but, whereas the former is almost untouched, the latter is so closely nibbled by the animal's teeth, and so trodden down by

its hoofs, that it looks just like the spot which a travelling circus has recently vacated.

Horses and cows act in very much the same manner. They will stand for hours close to the boundary, and be quite grateful to any one who will pluck them some of the grass that grows without their limits, even though it be inferior to that within them. A gate is a favourite resting-place, both with horses and cows; and they often press so heavily against it, that they injure the fastenings.

The late Charles Waterton pointed out to me a device which he had put in practice on his estate at Walton Hall, near Wakefield. He found that when the cattle were on the side towards which the gate opened, they did no great harm, because they only pushed it against the post; but that, when they were on the opposite side, all the strain came against the hinges and latch. So on the inside of every gate he had a strong chain fastened to the left gate-post by a staple, and to the right by a stout iron hook.

The chain was set at the average height at which the breast of a horse or cow would press against it, and, by means of the hook, it could be unhitched whenever the animals had to be moved. By means of this ingenious device, it is impossible for the cattle to damage the fastenings of the gate, as in the one case the pressure was against the posts, and in the other against the chains.

Close to my house there is a ludicrous example of the trespassing instinct.

There is a stable, with an open yard attached to it, and surrounded by a high park fence. The owner of

the stable, being of a humane disposition, allows his horse to roam at large in the yard. Not content with this amount of liberty, the animal is always trying to cross the barrier that separates him from the rest of the world, and has contrived, in some way or other, to get his head over the fence, so as to enable him to survey the country at large. Many a lady has been frightened, when walking along the path, to see his great head flung suddenly over the fence; and even to those who know the animal and his ways, the sight is rather startling on a dusky evening.

The same feeling holds good with human beings. I suppose that there never yet was a schoolboy who did not always experience a burning desire to cross he legitimate bounds of the school, no matter whether they be far or near. Indeed, so well is this feeling known, that in more than one school all bounds have been abolished, and in others a quaint sort of compromise has been virtually agreed upon between the boys and the master.

If a master happen to meet a boy out of bounds, and the latter conceals himself, even though by pretending to hide behind a sapling not an inch thick, or, in default of any such advantage, by turning his back, and making believe not to see the master, the latter also pretends not to see the boy, though they may be close to each other. Should, however, the boy give any recognition of the master, or even look him in the face, he is considered to be in open defiance of the rules, and punished accordingly.

Men act in just the same manner. All those who have read history, whether ancient or modern, must be

familiar with many instances where persons who had been banished from their country, on pain of death, have been irresistibly drawn towards the frontiers; and though they knew that their lives would be forfeited if they were captured, have been unable to resist the impulse that urged them to trespass across the forbidden line.

Not many years ago, there existed in the vicinity of certain prisons a few streets, technically named the "Rules" of the prison. In these "Rules" any one imprisoned for debt might live, without being actually within the walls of the prison, provided that he could pay the high rental demanded.

If he ventured across the boundary of the "Rules," were it but by a foot, he might be captured, and then would be strictly confined within the walls of the prison. This partial liberty was certainly a considerable privilege, though, in fact, it was more apparent than real. For, so deeply does human nature resent the existence of any boundaries, that the residents within the Rules found them scarcely less galling than the prison itself. They would come to the entrance of the street, stand as close as they could to the line of separation, and gaze wistfully at the world with which they might not mix.

Sometimes, after watching carefully so that no enemy might be in sight, they would jump across the boundary; and occasionally one of them, bolder or more active than the rest, would run fairly across the street, touch the opposite wall, and dart back again, amid the envious congratulations of his companions. He really felt much better after an exploit

of this kind, which was a brief taste of the sweets of liberty.

Perhaps the spice of danger added to the enjoyment of the trespass. For there have been instances where spiteful creditors, baffled by the debtor's refuge in the Rules, have placed cunning officers within hiding, and so have captured their unfortunate debtors, and deprived them even of the small modicum of liberty which they had been permitted to enjoy.

Even where man is not a prisoner in this sense of the word, he feels himself a prisoner in many others, and is always trying to pass the boundary. Pent by the sea within an island, no matter how large, he is sure to break through the boundary by artificial means, and by a vessel, a boat, a raft, or even a log of wood, to trespass beyond his original domains.

Viewing the birds, insects, and other winged creatures disporting themselves in the air, man at once repines at his imprisonment upon earth, and longs to follow them in their aerial flights. "Oh, that I had wings like a dove!" is the natural cry of man; and from the time of Icarus to the present day, he has never ceased from the attempt to make himself wings, and to launch himself boldly into the regions of air.

By means of the balloon, he has succeeded in sustaining himself for a certain time above the earth, and has risen to an elevation far higher than any which a bird has as yet been known to attain. In fact, pigeons, when thrown out of the car of a balloon, have been seen to fall perpendicularly for a considerable depth, before they found the air sufficiently dense to support them.

Man is not, however, satisfied with the balloon. In the first place, he wishes to be perfectly independent of a huge machine like a balloon, to be able to rise in the air at will, and, as do the birds, to guide his own course on his own wings.

There is, perhaps, no one who does not feel an innate yearning after such a capability. It even visits us in our dreams; and there are very few who, in dreamland, have not soared at will through the air, serenely conscious that at last they had attained the fruition of their long-delayed ambition.

Will man ever succeed in this object? I am inclined to think that he will, and that he will do so by means which have escaped us from their very simplicity. To fly through the air is really no more difficult a task than the practical annihilation of space and time by the electric telegraph, of which Puck's forty minutes' journey round the earth was but an imperfect prophecy.

I am inclined to think that the very fact that the idea has for so many centuries existed in the mind of man, and that so many attempts have been made to convert the idea into a practical reality, is, if not a proof, yet an indication, that such a result will be, sooner or later, attained.

There has been much verbal wit wasted on the many failures, and much pictorial wit is displayed by caricatures. These, however, rather tend to counteract themselves; for there is no great discovery which has not been preceded by similar caricatures, whether of pen, pencil, or both. For example, I have before me a caricature of a steam-carriage, drawn but a very few

years before the introduction of the railway system. Of course, the engine is in the act of bursting; the artist intending to convey the idea that locomotion by steam is too dangerous to be attempted.

Perhaps some of my readers may have Gilray's caricature of vaccination. The scene is laid in the inventor's operating-room, and Jenner is engaged in vaccinating a number of patients, from all parts of whose bodies miniature cows, calves, and bulls are protruding themselves. Yet neither of these sciences was hindered by caricatures, though they created, or rather increased, the popular prejudice which is sure to be aroused against any great advance or improvement.

In Miss Eden's charming work, "Up the Country," which is a description of her travels with her brother, Lord Auckland, in India, where he was Governor-General, there is a most singular instance of ridicule cast on a noble invention, through simple want of appreciation or foresight.

They were halting at Umreepore, and went to visit a certain physician, who had the reputation of being very scientific, though slightly insane. So he was; but, in the present instance, the very facts that showed his real scientific powers were accepted as proofs of his insanity.

Magnetism and electricity were his special hobbies, and in his case madness was certainly allied to genius. He had some fantastic notions about Solomon's Temple, which he asserted to have been made by the magnetic angles of a stone brought from Egypt. He had found stones with similar properties at Gwalior,

and with their aid had constructed a model of the Temple, which he presented to Miss Eden.

This was bad enough; but the worst was to come. Not only had he discovered the principle of Solomon's Temple, and enabled any one to reproduce it, but he had invented a plan of instantaneous communication between distant places, by means of electricity and wires. "So then he showed us that experiment; and a great many of the galvanic *tricks* were very amusing."

The man had actually discovered the electric telegraph, and this invention which has well-nigh changed the aspect of civilization, was only taken as a proof of insanity. The experiment was shown to Miss Eden in 1838.

Afterwards when the invention was comparatively perfected, it was offered to the Government, in order to supplant the clumsy semaphore, which some of my readers may remember on the roof of the Admiralty, and which was absolutely useless in foggy weather. Let there be but a fog, and an enemy's fleet might effect a landing long before their approach could be known. Then as the signs had to be repeated through a succession of stations, the process was very slow, when compared to the instantaneous communication of electricity. Yet "My Lords" rejected the invention on the ground that no other mode of telegraphy, except that in use was advisable or necessary.

As we all know, gas had to fight its way against the theorists and alarmists, the latter showing that any town lighted by gas must inevitably be blown up. Satirists and alarmists have never succeeded in arresting, though they may have delayed, the pro-

gress of science, and I cannot but think that our yearnings for aerial travelling will one day be satisfied, and that railways will be to the aerial carriages what waggons are to railways.

We pass to another element—namely, the water, in which man also becomes a trespasser.

The simplest and most natural mode of trespassing in this element is by swimming; and every swimmer knows the exultant delight with which he lies rocked in the heaving waves, or dives through the curling, white-topped breakers with as much security as if he were reclining on a feather-bed at home. Still further does he trespass by the act of diving, and exults in his power of penetrating into the depths of the sea, and defying, though for a short time, the power of the water.

As he progresses in civilization, he is proportionately dissatisfied with his natural powers of trespassing, and resorts to art. The log becomes a raft, is modified into a boat, and soon is magnified into a vessel. The wind is pressed into the service of man, and aids him to propel his vessel by means of sails. At last, dissatisfied with a vessel that is dependent upon the wind, and anxious to be able to trespass upon the ocean at his own will, man applies the power of steam to his ship, and so becomes independent of wind, tide, or any other obstacle to his progress.

Nor is he yet satisfied. It is not enough to trespass upon the surface of the water. He wishes to emulate those air-breathing creatures which are enabled to spend most of their time beneath the surface, and contrives, by means of diving-bells and diving-dresses,

to remain beneath the water much longer than those creatures whom he imitates.

This dress, by the way, is not so modern an invention as is generally thought, although its present state of perfection is necessarily owing to the modern improvements in machinery. In the Ambras Collection there is a manuscript of the fifteenth century in which are represented several men in diving dresses, and furnished with stoppered vessels of air, which they can breathe when needed. It is true that the value of compressed air for respiratory purposes was not known at the time, and that a single vessel could only contain air sufficient for two or three respirations. The principle, however, had been recognized, and its further development was only a work of time.

As to fire, it has at present baffled us, and all that we can do is to delay its conquering powers.

There still remains the Earth, into which man is becoming daily a more accomplished trespasser, his powers in this respect increasing, together with his civilization. The savage never troubles himself about penetrating into the earth any more than he does about rising into the air. He may make use of a cave by way of a habitation; but there he stops. Whereas civilized man must needs act the trespasser in the domains of earth, as he does in those of air and water. He digs mines, which descend to vast depths, and traverses the earth with a network of subterranean galleries.

Or, dissatisfied with the mountains that divide one district from another, just as he is dissatisfied with separating seas, he drives his tunnels through

them, and so renders himself independent of the barriers which formerly hindered his progress. Should the proposed tunnels succeed in connecting Southampton and the Isle of Wight, or, as is hoped, England and France, the power of man as an earth trespasser, will, at all events for a while, have attained its acme of perfection.

But however great his power, he has been anticipated by creatures which are still lesser than himself in the scale of creation, and at present he can but offer an humble rivalry to many, while he is infinitely surpassed by others. Some of these I will now lay before the reader, for the purpose of showing the wonderful, though simply-planned modifications of structure which permit them to trespass, and which may, perhaps, give to us some hints for furthering our own progress in the conquest of Nature.

CHAPTER II.

Marine and Aquatic Trespassers.

THE WHALES.

As those animals which trespass upon the domains of water are far more numerous than those which trespass upon air or earth, we will take them first in order.

It is a very remarkable fact that among the mammalia, which are all breathers of atmospheric air and are hot-blooded, so as to be incapable of existing without frequent and thorough respiration, there should be a vast number which are either totally or partially, inhabitants of the water. There is a regularly graduated series of them representing almost every known group of mammalia.

Some live entirely in the water, and are quite as dependent on it for existence as if they were fishes; some pass more of their time in the water than on the land; some divide their time totally equally; while others live chiefly on land, but resort to the water either for food or shelter.

At present no aquatic representation of the monkey

tribe has been known, and there are not wanting persons who aver that even if none are known to exist at present, some have existed, and have been the cause of the legends respecting mermaids and mermen, which have been current in every part of the world where there is a sea coast, and where a written language exists. It is worthy of notice that in Japan, as well as in England, the legendary mermaid is quite familiar to the popular mind, and that it is from Japan that have been procured those ingenious compositions of skin, papier-maché, membranes, hair, teeth, bones, and scales, which have been palmed off upon the public as genuine mermaids.

In one sense they are very unlike the mermaid of romance. She was always represented as a veritable human being in size, as well as in shape, as far as the waist, while the rest of the body was that of a fish. She was also held to be superbly beautiful, and, by means of that beauty, to have decoyed many a heedless lover beneath the waves.

Now the Japanese mermaids are little more than mere dolls in point of size. The celebrated specimen of which Barnum made such a speculation, was not quite three feet in length—I speak from memory—because, though I saw it repeatedly, I did not measure it. The thing was hideously ugly, with the head drawn on one side, and the features contorted, as if it had died in fearful agonies. It was a mean, wizened, mummified, and most repulsive object, and except that it exhibited the junction of a mammal with a fish, had nothing in common with the mermaid of tradition. I have seen many specimens of Japanese mermaids, and

this is by far the largest, the generality seldom exceeding eighteen inches in length.

Yet, utterly absurd as they are, there are many persons who firmly believe in them. I once had a narrow escape from a personal assault at the hands of an owner of a Japanese mermaid. I saw it in his shop—a fishmonger's; stepped in to look at it, and made some remarks upon the ingenuity with which wire had been made to imitate ribs and other bones. I thought that I was paying a compliment, but very soon found that the sooner I was out of the shop the better it would be. I have even seen one of these objects in which the artist had been audacious enough to fasten a great pair of bat-like wings to the shoulders.

The origin of the mermaid is utterly obscure, and is lost in the mists of antiquity. Horace, in his "Ars Poetica," treats the popular idea of the mermaid as represented by modern artists—

"Desinit in piscem mulier formosa superne;"

which may be translated—

"A lovely woman with a fish's tail."

But the idea is far older than Horace. We find it in Dagon, the Fish God of the Philistines—a deity who is even at the present time worshipped in the same shape throughout Burmah, and whose gigantic images stand, all glittering with their golden scales, in the Burmese temples, exactly as they did in the time when Dagon fell prostrate before the Ark in Philistia.

We see the same idea of the union of the man and the fish in the ancient Assyrian sculptures. This idea

is not carried out in precisely the same manner, but it is nevertheless the same idea.

I need scarcely mention the absolute physical impossibility of such a being. In the fish and the mammal even the very blood is different, the mode of circulation is different, and the respiration is different. Had such beings really existed, they must have been not only seen, but secured. They could not have breathed without coming to the surface in order to obtain atmospheric air, and must have done so at such short intervals that they could not have escaped observation.

If, then, any aquatic representatives of the monkey tribe have ever existed, they must have been formed in a very different manner from those fabricated objects which have been put forward as mermaids, or from the conventional and poetical idea of such beings. When combs and mirrors grow wild in the sea, then will mermaids be found to use them.

Yet, although no such beings as mermaids exist, or have existed, the ocean holds creatures which are every whit as wonderful. It contains mammalia of such dimensions that the largest elephant is, in proportion to them, but as a cat beside an ox. Indeed, none but those who have seen them can have the least idea of a mammal which is more than ninety feet long, and so thick that if it were laid on the ground, the body would reach half-way from the first to the second floor of an ordinary London house.

I have only seen a few specimens which have been accidentally thrown on the shore, but even in these cases was greatly struck with the very great bulk of

the animals when compared with their measurement in feet and inches. A foot more or less, either in length or thickness, does not seem very much on paper, but in actual bulk a foot short makes the difference between a giant and a dwarf.

Take ourselves for example. A man of five feet six inches high is looked upon—not to say down upon—almost as a dwarf, while a man of six feet six inches is nearly a giant. Indeed, a man who measures six feet in height looks like a little boy when standing by the side of a man who is only three inches taller, and it may easily be seen that when bulk as well as height have to be taken into consideration, the difference in size is really astounding.

As a general rule, all the gigantic mammalia of the present day are exclusively vegetarian, such as the elephant, the hippopotamus, the rhinoceros, and the giraffe; not to mention the various species of buffalo, some of which are but little inferior in bulk to an ordinary elephant.

Here, however, we have the curious fact that the largest of living mammals are predacious, and that in order to supply their enormous bodies with sufficient food, they must either prey upon a few animals nearly as large as themselves, or upon vast numbers of smaller animals. The former alternative is clearly out of the question, and so they have to fall back upon the latter.

Some, such as the Greenland Whale, feed upon small molluscs, which they catch in the natural net which fringes their vast mouths. Some, such as the Spermaceti Whale, live mostly on the

cuttles and other large molluscs, while others are almost entirely fish-eaters. Now, the earth does not supply animal life in the teeming abundance which is required in order to supply these vast beings with food, and their lot is, in consequence, cast in the sea, which absolutely swarms with animal life in many forms.

When, therefore, one of the whale tribe happens to be stranded, it is sure to die, as does a fish when thrown ashore, though from different causes. The fish dies because it is nearly as incapable of breathing atmospheric air as is a man of breathing under water, whereas the whale dies for want of food. These animals act towards the small creatures which constitute their food much as do the vegetable-eating mammals of the land towards the leaves and herbage on which they feed.

They do not seem to have any particular time for feeding; but during all their waking hours are almost constantly engaged in taking food. A short sojourn on shore, therefore, is fatal to them, because they are deprived of the food supply which is absolutely necessary to their existence. Indeed, there are many true fishes, some of which will be mentioned in their places, which can live upon land very much longer than can a whale, or even a porpoise, and which are quite at home on the land, where they can not only breathe, but even obtain food.

It is no wonder that creatures which are so fish-like in their habits that they die like fish when taken from the water, should be mistaken for fish. Indeed, so deeply rooted is this idea, that many persons flatly

refuse to believe that whales are not fish. "They live in the water," say they, "like fish, they feed like fish, they die like fish when out of the water, and therefore fish they must be."

Now let us proceed to sum up the details of structure which enable these enormous mammals to take possession of the seas, and so to trespass upon the domains of the fish.

The power of respiration is necessarily the first requisite for a habitation in the water. Mammals, being hot-blooded creatures, require a constant supply of oxygenated blood, so that whales, being mammals, must have this first necessity of existence. The amount of blood which is poured through the system of a whale is perfectly astonishing. I never appreciated it until, while engaged in the Anatomical School at Oxford, I assisted in preparing a section of an aorta (*i.e.*, principal artery of the heart) that had been taken from a whale of moderate size. It looks something like a child's hoop, or a section of the main pipe of some large waterworks.

But I am quite sure that no one who was not previously acquainted with the subject would ever guess its real nature. Indeed, all those to whom I have showed it have experienced some difficulty in believing me, and have acknowledged that, without having seen it, they never could have formed the least conception of the gigantic proportions of the whale, and of the vast torrent of blood that is driven through its body.

Three problems now present themselves.

The first is this: The blood being there, how is a

creature which leads an aquatic life to keep such an enormous quantity of the vital fluid aërated. The second is this: How is the animal to obtain sufficient food to keep up the supply of blood, and to compensate for the waste that must be caused by the violent exertions that are inseparably connected with its aquatic life. The third problem is this: How to prevent the vital heat from being absorbed in the ice-cold water in which so many whales pass the whole of their lives?

These problems are by no means easy of solution, and it is really wonderful to see how beautifully and yet simply are they treated in the structure of the whale tribe. We will take them in order, and begin with Respiration.

Here, at the very outset, we are met by another problem. It is manifestly impossible that the animal should always remain at the surface of the water. In the first place, it would be unable to procure its food; in the second place, it would be exposed to the assaults of various enemies; and in the third place, it would be at the mercy of the storms.

For the largest whale that ever lived is powerless against a storm, which hurls its huge body about like a cork. Indeed, when the whale has been overtaken by a storm in comparatively still water, it is tolerably certain to be stranded, and it has sometimes happened that a whole "school" of whales have been flung ashore by a single gale. Now, as all good swimmers know, the power of the waves is quite superficial, and even a human being can set them at defiance by meeting them, diving just before they reach him,

and so allowing them to roll harmlessly over his head.

It is therefore absolutely necessary that the whale should be able to pass a considerable time beneath the surface, and be for that time deprived of the power of respiration. How can we reconcile these conflicting necessities?

The first and most obvious suggestion is, that the animal should be supplied with an internal apparatus, by means of which it can take down with it a supply of air that will suffice for respiration during the time of submergence. But, considering that the ordinary time during which the animal is under water is about an hour, and that it must be capable of extending that time if needful, it is evident that the air-vessel would be so large that the whale would be absolutely incapable of sinking at all.

This plan, therefore, is not feasible, and we must look for one which will give a supply of arterialized blood while the whale is under water. Suppose that, instead of giving to the whale a supply of air which will oxygenate the blood, it should have a reserved supply of already oxygenated blood, which can be passed into the system when required.

In fact, suppose that the whale has the power of acting, with regard to respiration, as the camel does with drink, and is enabled in a few minutes to oxygenate as much blood as will serve the purpose of life for an hour or more. If this can be done, the problem is at once solved, for the blood-reservoir will be very small when compared with the air-reservoir, and, not being lighter than the rest of the body, will not

interfere with the power of sinking or rising at will.

This latter condition is an extremely important one. As all human swimmers know, they can only keep themselves below water by continuous exertion, and as soon as it ceases they float to the surface. This is all well enough for man, but would be practically fatal to the whales, who ought to possess the power of rising or sinking without any such violent movements. They can compass this end by contracting the muscles of the body so as to lessen their size and make them rather heavier than an equal bulk of water, while as soon as the muscles are relaxed the animal becomes, bulk for bulk, lighter than water, and will float on its surface without effort.

Such a blood-reservoir as has been mentioned would fulfil the above-mentioned conditions, and it is just such a reservoir which is possessed by the whale.

The discovery of this reservoir was, I believe, made by William Hunter. At all events, the first description of it was published by him in the "Philosophical Transactions" for 1787.

The greater part of the cavity of the chest is lined with a vast mass of blood-vessels, forming a complete maze of tubes. On a small scale, the arrangement of these arteries can be tolerably imitated by taking a large quantity of macaroni, boiling it, and then plastering it in a thick layer against the ribs, making it thicker towards the spine than towards the ends of the ribs. These vessels take their origin from the "intercostal" arteries—*i.e.*, those which suppl

the region of the chest. They are twenty in number, ten on either side, and in the whale they are enormously developed, so as to produce the remarkable appendage to respiration which has been mentioned.

This, however, is not all. Beside this enormous mass of arteries, there is a corresponding network of veins, which appear to form reservoirs for the blood which has been passed through the system and become useless.

Even in these veins there is a difference in structure. In most veins there is a series of valves, which allow the blood to pass forward but not backward; so that, no matter how rapidly the heart may beat, the blood is propelled forward with corresponding force.

Any of my readers, who have been accustomed to running, or have subjected themselves to training, are familiar with the phenomenon called "second wind." When the first half mile or so has been passed, the action of the heart seems to be so much in advance of that of the lungs that the runner feels half-choked, gasps, and is almost unable to proceed. If, however, he doggedly perseveres, the feeling of oppression soon goes off, and he can then run for almost any distance without distress, as far as respiration goes. His legs may fail him, but his lungs will not.

The fact is, that after a little time, the blood that has been violently forced through the system, has had time to equalize its rate of progress with the increased pressure, and breathing becomes as easy as if the runner were seated at rest.

In the reserved vein-system of the whale tribe, however, there are scarcely any valves, so that the

blood moves but slowly through them, and can wait until the time comes for aërating the whole mass.

It will be seen, therefore, from this brief sketch, that the whales have, even in proportion to their vast bodies, far more blood than any other animals; the additional reservoirs containing blood enough to supply the enormous creature for more than one hour.

We have not yet come to the end of this subject. This enormous mass of reserved blood would be perfectly useless, unless the respiration were modified so as to enable it to be oxygenated in a short time. We will take as an example the adult male spermaceti whale, and see how he manages his respiration.

When the whale comes to the surface for the purpose of breathing, he lies nearly motionless, and then goes through a series of enormous respirations, called by the whalers, "spoutings." On the average, he makes some sixty of these respirations in regular succession, each occupying, as nearly as possible, ten seconds; so that the whole time employed in this operation is ten or eleven minutes.

The act of expiration is very violent, and as the animal always has the nostrils—which are technically named the "blow-holes"—situated on the upper part of the extremity of the head, filled with water, this water is ejected in a jet of thick, dense, white spray. The mode of respiration is very curious. First, the animal ejects the consumed air in "spouts;" the spouts occupying about three seconds. It then draws one rapid breath, of about a second in duration, and then sinks its nostrils beneath the water for about

six seconds, during which the respired air is employed in oxygenating the blood.

All these movements are made with the regularity of machinery, and each individual whale has its own particular number of respirations. This is known so well, that the whalers have only to watch one of these animals going through its spoutings, to know how long it will remain at the surface when it again makes its appearance. Should the creature be disturbed before it has "had its spoutings out," and dive, it is sure to return to the surface for a few minutes and finish them, when it will generally sink itself by "settling" down in the water, without performing the usual diving movement.

The same regularity extends to the duration of the animal's sojourn beneath the water, so that the whalers can always make their calculations as to the time when a whale that has dived will again make its appearance.

The reader will probably have observed that the respiration of the whale differs from that of ordinary mammalia in one important respect. Terrestrial mammalia do not make their respiration a separate business of their life, but breathe as they go about their ordinary duties, and without interrupting them. Whereas the whales are obliged to set aside a certain portion of their time for respiration, during which they are perfectly quiescent, and only think about oxygenating the vast storage of blood which is to supply them during their sojourn under water.

So we see that at least one-seventh of the whole time of the creature is occupied in respiration. This

applies to the male. The females seldom remain submerged for more than twenty minutes, and they occupy about four minutes in having their spoutings out; so that, in their case, one-fifth of their time is taken up by respiration.

Even we ourselves in, a small way, can imitate the whale in their mode of respiration, and produce a similar result.

Any one who wishes to hold his breath for a considerable time, can do so by preparing himself much as the whales do. Let him first expel, as far as he can, every particle of air from the lungs, and then take as deep an inspiration as possible. Let this be repeated for some twenty times, and the blood will be so completely oxygenated that another respiration is not needed for some little time. I have often been thus enabled to hold my breath for a minute and a half, and have found it a very useful accomplishment in diving matches, where a second more or less means winning or losing them.

Another important aid to respiration is found in the substance from which the spermaceti whale derives its name. The skull is comparatively small, the greater part of the enormous head being composed of a very light oily substance, enclosed in a thin membranous case. It is this oil which, when purified by pressure, and treatment with successive washings in alkaline solutions, crystallizes into the well-known spermaceti.

The object of this substance is evident enough when we consider the habits of the animal. On account of its lightness, it very much increases the

bulk of the head, without adding much to its weight, and so renders it lighter than water. In consequence of this structure, when the whale rises to the surface of the water for the purpose of respiration, the head floats as easily as a cork; and without any exertion on the part of the animal, the nostrils are kept well above the water.

So much for respiration, as the act by which the whale purifies its blood. We will now proceed to Feeding, as the act by which the animal keeps up the supply of the vital fluid.

As examples of the same end attained by different means, we cannot do better than take the Cachalot, being a toothed whale of the Southern Seas, and the Greenland whale being the toothless whale of the Northern Seas. There are plenty of others, but these afford the best types of the mollusc-feeding whales, the former living on the large, and the latter on the small molluscs.

The jaws of these animals are beautifully adapted for the purposes which they have to fulfil. In the former, the upper jaw is nearly toothless; whereas the lower jaw is furnished on each side with a row of large conical teeth, set at some distance from each other, and fitting into cavities in the upper jaw.

These teeth, by the way, were at one time the most cherished and valued objects that could be possessed by Fiji or Friendly Islander, some peculiarly sacred character being attached to them. None but a chief could possess so coveted an article; and many disastrous wars have taken place because the principal chief of one island had obtained possession of a whale's

tooth, and would not give it up to the principal chief of another island.

A singular example of the passion for whale's teeth is given in Mariner's account of the Tonga Islands. A whale had been thrown on a small island, inhabited only by a man and his wife, and the king came, according to custom, to take the teeth. Finding only two, he demanded the others from the man, who produced two more from a basket, and declared that there were no more. His wife, however, confessed that she had secreted one, which she gave up. Nothing could induce either of them to acknowledge that they knew of any more teeth; and first the man and then the woman were killed with clubs.

Some years afterwards the missing teeth were discovered on the island, carefully buried, so that these extraordinary people actually preferred to lose their lives rather than their treasure.

With these teeth the spermaceti whale seizes its prey, which consists almost exclusively of cuttle-fish of various species, mostly those which are called "squids;" Mr. Bennett asserting that he has often seen large limbs of the squid floating on the water, having evidently been bitten off. He always used in such cases to look out for spermaceti whales, and never failed to find them.

It seems rather strange that such creatures should form the food of the whale. In the first place, the suckers with which their arms are thickly set can cling so tightly to any object, that it is a wonder how the whale can manage to get them down its throat; and in the second place, they are so active that the narrow

jaw of the whale seems quite inadequate to their capture. Many species can even shoot through the air to a considerable distance, if hard pressed.

Yet the whale never seems to be in any distress for food, an emaciated one never having been found. Nor is sight required for the capture, as whales have been taken which have been absolutely blind, and yet were in as good condition as their fellows who had the use of their eyes. Sometimes the whale contrives to capture an enormously gigantic cuttle, large enough, one would think, to defy even the whale itself. Dr. Schwediawer mentions, in a letter published in the "Philosophical Transactions," that a spermaceti whale was captured, in whose mouth was a tentacle of a squid that measured twenty-seven feet in length. This, moreover, was not the complete length, as one end of it was wanting.

It is believed that the mode by which the whale catches the squids is by rushing through the water with open mouth, and taking its chance as to finding prey. This theory is strengthened by the fact that the remains of fishes, generally the rock cod, are sometimes found in the stomach of the whale, though, as a general rule, there is nothing but mangled cuttle-fish, whose horny beaks defy the digestive powers of the captor. Once, part of a dolphin's tail was found within a whale, but such an occurrence as this is not likely to happen again. In a future page, we shall see how the Greenland, or oil-whale, manages to find its food in the northern seas, where there are but few large molluscs.

I may here observe, casually, that ambergris is

almost entirely composed of partially-digested cuttles, their beaks being often found embedded in the mass. There was for many years an utter ignorance of the real origin of ambergris, but, as it has been taken from the interior of the spermaceti whale, and the remains of cuttle can be recognized in it, there is no longer any doubt on the subject.

We have now seen how this mammalian trespasser in the water is able to support its existence in that element; we have seen the remarkable modification of the blood-vessels, which enable it to aërate the blood, and the mode by which the volume of that vast blood-supply is preserved undiminished. We have now to see how the whale, being a hot-blooded animal, is able to pass its whole existence in water, which, especially in the cold seas in which so many of them live, would rob them of the heat which is so needful for them. This point is very well put by Mr. Rymer Jones in his "General Structure of the Animal Kingdom," a book through which I had the pleasure of dissecting my way:—

"The Cetacea form a very remarkable group of hot-blooded Mammifers, as related to the external covering of their bodies. No covering of hair or wool would have been efficient in retaining the vital heat under the circumstances in which these creatures live; and, even if such clothing could have been made available, it would seriously have impeded their progress through the water.

"Another kind of blanket has, therefore, been adopted. The cuticle is left perfectly smooth and polished, without any vestige of hair upon its surface.

But, beneath the skin, *fat* has been accumulated in prodigious quantities; and, enveloped in this non-conducting material, the whales are fully prepared to inhabit an aquatic medium, and to maintain their temperature even in the Polar seas."

This structure, which is appropriately called by sailors the "blanket," is of a very remarkable character. There are plenty of animals, notably the swine, the hippopotamus, and the like, which, when in good condition, have a thick layer of fat beneath the skin.

In all these animals the skin can be removed, leaving the fatty layer in its place. This, however, is not the case with the whale tribes, in which the blubber, as this peculiarly fatty substance is called, is really but a modification of the skin itself, and is composed of a mass of interlacing fibres, the spaces between which are filled with oil. A good idea of this structure can be formed by comparing it with that of an orange, the juice of the fruit taking the place of the oil, and the sponge-like cells in which it is held representing the tissues of the skin. Consequently, the skin and the blubber have to be separated by the whaler's "spade," before the oil can be expressed from the labyrinthine fibres among which it is entangled.

Such a substance as this is of necessity exceedingly elastic, and Sir W. Jardine has happily compared it to India-rubber, "possessing a density and resistance which, the more it is pressed, it resists the more." The reader will see, therefore, that this wonderful structure fulfils a double duty. In the first place, it acts as a non-conducting layer between the vital parts and the water, thus preserving the animal heat; and, in the

second place, it acts as a safeguard against the tremendous pressure of the water at the depths to which the whale descends.

Whales have been known to dive perpendicularly, carrying with them such a length of line that if a bottle had been sunk to the same depth, corked, sealed, and closed in every way, the water would have forced its way through everything, and filled the bottle. Pieces of wood that have been sunk to such depths are found to have the water driven into every pore, so that they can no longer float, but sink as if they were bars of iron.

Such a pressure as this, if exercised directly upon the body of the animal, would be fatal, but the thick elastic coat of blubber yields to the weight of water, and is itself compressed without transmitting the pressure to the vital organs.

The reader may, perhaps, ask how it is that the aperture of the nostrils can be sufficiently closed to keep the water from forcing its way into the lungs. This is done by means of a beautifully-formed valve, which can only be opened by force applied from below, and is spontaneously closed by force applied from above, fitting more and more tightly in proportion as the pressure increases.

Thus we see that although we cannot, without hermetically sealing it (*i.e.*, fusing the glass together), close a bottle so tightly that the water cannot force its way through the obstacles, the living whales possess a self-acting valve through which they can respire when at the surface, but which is absolutely impervious to the water, no matter at what depth the animal may be.

In fact, even supposing that the whale were to attempt to expel the air from its lungs when below the surface, it would be unable to open the valve, the pressure from above being too strong to yield to any force that the animal could apply from below.

All the whale tribes possess this structure, but it is developed to the fullest extent in those animals which are obliged to descend to considerable depths below the surface of the water. This valve is formed much after the fashion which is adopted in the heart and veins—namely, it is composed of elastic bags, which, when filled, press firmly against each other, but, when empty, fall into wrinkled folds, leaving a clear passage between them.

A few words as to the general form of the whale tribe.

It is almost exactly the same as that of the fish, inasmuch as the movements must necessarily be of a similar character. As the whole body is sustained in the water, the limbs are not required for support, and are modified to suit the peculiar life which the animal leads. The fore limbs are very short, very wide, and very flat, so as to act as fins, and are apparently used for the purpose of balancing the animal rather than aiding or even directing its course.

As to the hinder limbs, they are not needed; and in some are altogether absent. There is not even a rudiment of them, and the pelvis itself is wanting, being only represented by a small bone lying loose in the tissues.

Thus, the whole of the body behind the thorax is flexible; and, unlike that of fishes in general, can

be moved from side to side, or up and down, according to the will of the animal. The end of the body is flattened out into a broad and powerful tail, popularly called the "flukes." This tail, though shaped like that of a fish, is differently set. When a fish is in its natural position, the tail is perpendicular, and a forward movement is obtained by moving it from side to side; but, in the whales, the tail is set horizontally, so that when the animal is at rest, it lies flatly upon the surface of the water. The forward movement is therefore obtained, not by sweeping the tail from side to side, but by moving it up and down. It is believed that this modification of structure is due to the habits of the whale, which must possess the power of diving rapidly. In so doing, it strikes the water with its tail, so as to throw itself partly into the air, and then dives almost perpendicularly, the flukes waving in the air as it descends. So powerful is this instrument of propulsion, that in spite of its enormous weight, a whale measuring a hundred feet in length can throw itself completely out of the water, and can urge itself along the surface at a rate of some fifteen miles an hour.

The organs of hearing are curiously modified when compared with those of the terrestrial mammalia. Water is a much better conductor of sound than air; and, if the ear of the whale were constructed like that of a land animal, a single blow struck on the water by the flukes of one whale, would stun all the rest in the immediate neighbourhood.

This transmissive power of water is utilized by beaver-hunters. In the winter-time a hunter sometimes sees a beaver attempting to escape by swimming

under the ice. He instantly strikes a heavy blow on the ice with the back of his axe, which stuns the animal almost as effectually as if the blow had been dealt directly; so that a hole can be cut in the ice, and the lifeless body lifted out.

Now with the whales, a very difficult problem has to be solved—namely, to make a mammalian ear that is capable of hearing sounds below the surface, and yet will not be too sensitive, and will not admit water. The first difficulty is solved by the manner in which the internal ear is constructed. That portion of the temporal bone in which the organ of hearing is placed does not form part of the skull, but is quite separate, and only held in its place by ligaments. Next, the orifice of the ear is exceedingly small; so tiny, indeed, as almost to escape observation. In spite of the enormous size of the whale, the external aperture is so small that a crow-quill can hardly be introduced into it.

The most remarkable part of the organ is yet to come.

We have seen how the animal is enabled to hear sounds which are transmitted through the water, and the wonderful manner in which the auditory organs are modified for that purpose.

But another problem now arises. As the animal spends a considerable portion of its time on the surface, it must also be able to hear sounds which are transmitted through the air, lest it should be surprised by foes which are out of the range of its vision, and which it is unable to detect by hearing. The tiny apertures which serve perfectly well for the trans-

mission of sound through water, would be absolutely useless when air is to be the transmitting medium.

The manner in which this most difficult problem—not to say paradox—is solved, is singularly beautiful, and is simple as it is effective. It is done by a sort of reversal of the ear.

Perhaps the reader may not be aware that there are two opposite openings in the ear—namely, the external opening, which we all know, and the internal opening, called the eustachian tube, which passes from the internal auditory organs to the back of the mouth, just where the nostrils open into it. Sometimes this tube becomes choked; and in that case, deafness—often incurable—is the result.

Although so few persons, except those who have studied anatomy, are aware of the existence of this tube, we all unconsciously make use of it. For example, if human beings are earnestly endeavouring to catch sounds, and are forgetful of everything but those sounds, they instinctively open the mouth, so as to hear with the eustachian tube as well as with the external orifices. Shakespeare, who seems to have noticed everything, has not allowed this instructive action to escape his observation. Speaking of the rumours concerning Arthur's death, he writes as follows:

> "I saw a smith stand with his hammer, thus,
> The whilst his iron did on the anvil cool,
> *With open mouth* swallowing a tailor's news."

Now, in the human ear, the eustachian tube is very small in proportion to the external orifice; but

with the whale the case is exactly reversed. The external orifice is, as we have seen, extremely small; but the eustachian tube is very large. This tube opens into the nostrils, or blow-holes, just behind the valve that keeps out the water; so that when the animal rises to the surface, and the passage of the nostrils is opened, the whale is able to hear atmospheric sounds through the eustachian tube. Thus, the creature is doubly armed: its tiny external ear conveying sounds that are transmitted through the water; and its large eustachian tube receiving those that are conveyed through the air.

As for the sense of smell, it appears to be totally absent, and this for two reasons. In the first place, it would be impossible for the animal to use the sense of smell while below the surface, unless, as Mr. R. Jones tersely puts the case, "it had the nose of a fish, which could not be granted without infringing upon the laws that regulate the progression of animal organization." When the creature is at the surface of the water, the sense of smell is not needed, and, as has been mentioned, the nostrils are required for another purpose—namely, that of respiration, and are so filled with water that no scent could reach them through the air.

The foregoing remarks have been based upon one species, the Spermaceti Whale. Reverting for a short time to some of the structures which have been briefly sketched, we shall see how they are further modified in another species of the cetacea, a perfect water trespasser.

The great Greenland, or right whale, which inhabits the Northern seas, has most of the habits which

distinguish the Spermaceti Whale of the South. The general form is much the same, but there are one or two important distinctions.

In the first place, the animal feeds almost wholly upon small shell-less molluscs, usually those which are known under the name of *Clio borealis*, and are about as large as the common white slug of our gardens. The great brown slug which is so often found by entomologists when "sugaring" at night for moths, would make three or four of the clio. These little creatures are soft-bodied, about an inch in length, and rather conical in form, the broader end of the cone being in front. No one who was not acquainted with the real facts would ever think that so small a creature could supply food for the vast bulk of the Greenland Whale.

Yet it is from these little molluscs that the animal derives almost the whole of its food; and, indeed, the gullet is so small that it could not, by any manner of means, admit the passage of any large morsel of food. It has been said that a penny loaf will choke a Greenland Whale, so that, although the Spermaceti Whale can swallow large fishes on occasion, and even accommodate a dolphin, the Greenland Whale would not be able to eat a common carp of a couple of pounds' weight.

In this animal the teeth are modified into the remarkable substance which is called by the popular but absurd name of whalebone. It is, like the horns and hoofs of the cow, the horn of the rhinoceros, the spur of the cock, the nails of the human being, and the claws of the predacious animals, a production of the skin exactly analogous to hair and feathers.

There is a second modification also, which is worthy

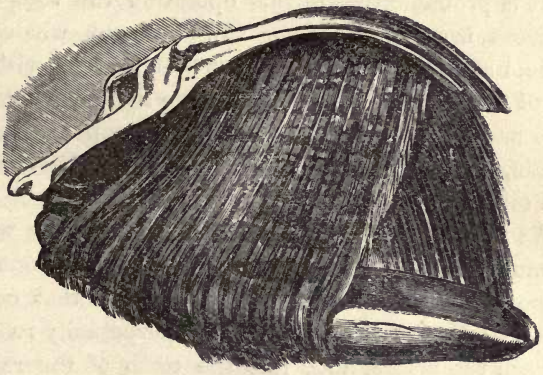
of notice. In the Spermaceti Whale the teeth are almost entirely confined to the lower jaw, whereas, in the Greenland Whale, the substitute for teeth is entirely confined to the upper jaw. Each structure answers the same purpose, but is altered to suit the material on which it has to work.

From the upper jaw start some six hundred plates of whalebone, or "baleen," as it is more properly called. In one species, the Rorqual, there are no less than five thousand of these plates. They vary in size according to the size of the individual, and the position which they occupy in the mouth; but in a full-grown whale, the largest plates will measure some thirteen feet in length, and nearly a foot wide at the base. They become rather narrower towards the point, but are there split up into fan-like sprays of hair-like fibres. The plates of baleen vary much in length, those at the tip of the jaw being the longest, and those at the base the shortest, so that when the mouth is partly opened, the baleen forms a sort of cage all round it.

The mode in which these plates enclose the opened mouth may be seen from the accompanying illustration. Some years ago, when I was living in Paris, I was greatly struck with the fine skeleton of the Greenland Whale that is kept in the Museum of Comparative Anatomy in the Jardin des Plantes. In this admirable specimen, the baleen has been retained in its natural position, and as the mouth has been shown as it appears when open, the beautiful arrangement of the plates is far better seen than would have been the case with the jaws closed.

I at once purchased a photograph of the jaw, and had it engraved for my "Illustrated Natural History," published by Messrs. Routledge and Sons, by whose kindness the illustration is permitted to appear in the present work.

In keeping this illustration in his mind, the reader may easily comprehend the manner in which the Greenland Whale obtains its food. The Northern seas absolutely swarm with the clio, and other small marine beings. The whale, when it wishes to feed,



SKULL OF GREENLAND WHALE.

opens its mouth, and drives through the sea at its best speed. As it passes along, the water through which it rushes is enabled to escape between the narrow interstices of the baleen plates, while the inhabitants of the water are intercepted as if by the gratings of a sieve. When the whale has obtained a fair mouthful, it expels the rest of the water from its mouth, swallows the enclosed prey, and then sets off again for another mouthful.

It has been thought that the spoutings of the whale are due to food rather than respiration, and are produced by driving the water from the mouth through the nostrils. This, however, is not the case—the whalebone acting as strainers at the sides of the mouth, and not across the nostrils. There is not the least necessity for blowing off the water in order to swallow, for the mere act of closing the mouth will drive the water through the plates of baleen, while the mass of little molluscs and crustacea is left behind.

It is probable that in this operation the tongue is of great service. I never saw but one whalebone whale, but in that instance I was much struck with the size of the tongue. It seemed to be little more than a large mass of blubber, and, on pressing upon it in the middle, a deep hollow was formed, which slowly filled with oil.

As is the case with most animal structures which are much exposed to wear and tear, the whalebone has the power of self-renewal from the waste that occurs by the friction of the water that is perpetually rushing between the plates, and, like the teeth of the rodent animals, it is renewed as fast as it is worn away.

Perhaps the reader may have wondered at the enormous size to which the head attains in the whale tribe, and especially in the two species which have been taken as examples. That an animal of ninety feet in length should have a head measuring thirty feet, does seem almost incredible, but, from the description which has been given of the animal's habits, the reader will see that with a smaller head neither creature could live. The head is, in fact, a sort of trap, in which is

caught the food which is necessary to support life, and if that trap were smaller the whale could not procure sufficient food to maintain itself.

From the very nature of their food, it is evident that they cannot chase it as do those animals which hunt their prey either by the eye or the nostril. The latter sense would be, as we have seen, absolutely useless in an animal that lives in the sea and procures all its living from submarine creatures. The former sense would be equally useless, as, in the first place, scarcely any light can penetrate to the depths into which the whale descends; and, in the next place, the animal would be in a very bad way if the Greenland Whale had to chase the tiny molluscs, or the Spermaceti Whale the cuttles, as swallows chase flies.

In point of fact, even if there were sufficient light to enable the whale to see its prey, the eyes of the animal are so situated that they are unable to see any object directly in its front, so that they are utterly useless in the chase of prey. Indeed, as we have already seen, a whale is quite as able to procure its food when blind, as if it possessed its full visual powers. The whalers are perfectly aware of this fact, and always try to approach a whale either directly in front or in rear, knowing that the animal is equally unable to see in either direction, although it has a wide range of vision on either side.

Before we leave the whales proper, there is just one point to be noticed as a distinction between the Spermaceti Whale and its Greenland relative. Both, as we have seen, are constructed in much the same way, the whalebone of one being, in fact, only a modification of

the other's teeth. Both are encased in blubber, but in the Greenland Whale this coating is very much thicker than in the Spermaceti Whale. The reason is simply this, that the seas in which the former animal lives are colder than those of the southern seas, and that, therefore, it must be protected by a thicker blanket of non-conducting material.

CHAPTER III.

DOLPHINS AND SIRENS.

We now pass from the whales to another group of mammalian trespassers, which are called by the popular names of Porpoise and Dolphin.

With regard to the former of the two words, there is a difference of opinion with regard to its orthography, some persons spelling it as porpoise, and others as porpesse. Personally, I incline to the former of the two arrangements, because the word porpoise is clearly a slight corruption of the French name, porc-poisson, *i.e.*, swine-fish.

In many respects the Porpoise agrees with the whales, but in others it widely differs from them. It agrees with them in the peculiar mode of respiration, although, as it has not to remain below the surface of the water for so long a period, the blood-reservoir is not nearly so large. Like the whales, its body is encased in a layer of fat, but, as it inhabits the more temperate waters, the "blanket" is comparatively thin, and scarcely more than an inch in thickness.

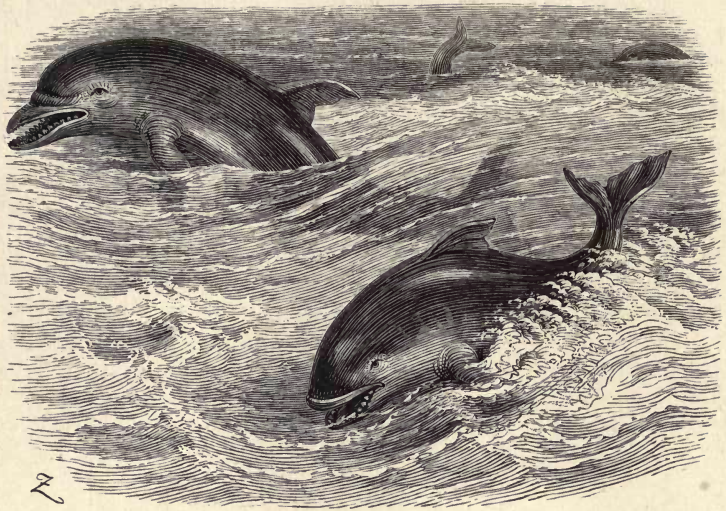
One of the principal differences lies in the size of

the head, which is comparatively small, and is armed with a row of sharply-pointed teeth in each jaw. The Porpoise, in fact, is essentially a fish-eater, and this fact explains its habitual liking for waters which are within easy reach of some coast. As is well known by all seamen, there are very few fish to be taken in the open sea, and even where fish are found under such circumstances, their presence is generally the indication of some sunken rock which has hitherto escaped the observation of marine surveyors.

Now, as the fish cling to the shores, and as the Porpoise feeds on fish, it is evident that the Porpoise must remain in the vicinity of its food. The animals do sometimes make their way up tidal rivers, and so penetrate to a considerable distance inland; but I do not know of any instance where a Porpoise has been observed on the high seas.

As the Porpoise feeds upon the active fish, and can chase and capture even the swift and powerful salmon, it is evident that the structure of the head must be very different from that of the whale. Accordingly, we find that the head is much advanced in front, so as to allow of vision in a straight line. The jaws and teeth, also, must be very different.

The fish being comparatively of large size, when compared with the molluscs on which the whales feed, there is no necessity for so large a head; and accordingly we find that it is not larger, in proportion to the size of the body than is that of the lion, the bear, or any other predacious animal. The mouth has certainly a wider gape, but nothing like that of the whale.



CUT 1.—DOLPHIN AND PORPOISE.

The teeth are modified in accordance with the task which they have to perform. They are very numerous, some forty or fifty on each side, and are so arranged that when the jaw is closed, they interlock with each other. This is needful, on account of the nature of their prey. The fish on which it feeds are not only active; but, as a rule, are defended with a scaly armour, which would enable them to slip out of the grasp of a mouth less formidably armed.

The teeth are rather long, sharply pointed, and are all alike; there being no distinction between incisors, canines, and molars. If a section is made of them, they are seen to be hollow cones, supplied with fresh substance of a soft pulp which fills the interior. They are exceedingly variable in number, some falling off in front, while others are developed behind, their number apparently depending on the size of the jaw.

One main point in the economy of the Porpoise is the flexibility of the body. This is absolutely necessary in order to enable the animal to turn and twist in the water with sufficient activity to take its prey. Sometimes it is able to come upon a shoal of herrings, pilchard, mackerel, or other fish; and works frightful havoc among them, driving into the shoal, and snapping up the fish as they are crowded together and hampered in their movements. But these are exceptional pieces of good fortune; and when the Porpoise has to match itself against such a fish as a salmon, it needs agility as well as speed; and those who have seen it while engaged in salmon hunting,

have been very much struck with the exceeding grace of its swift movements, as it twists and turns in the water, following and often anticipating every movement of its agile prey.

There are many of these creatures, some of which, as they attain a large size, are properly known as whales. Such, for example, is the Beluga, commonly called the White Whale, on account of its creamy white colour. It sometimes attains to the length of twenty feet, and is therefore so large an animal that the popular title of whale is a very natural one. It is however, simply a very large Dolphin; and has all the characteristics of its tribe, including the extreme agility which is necessary in capturing prey. Whalers, therefore, seldom attempt its capture, for, in the first place, its exceeding activity makes it a difficult mark for the harpooner; and in the next place, even if the harpoon be successfully thrown, the beluga can generally manage to shake it out again.

The Greenlanders, however, in their light canoes, manage to capture it; and in many parts of North America, where it enters the tidal rivers in search of fish, it is captured by means of nets, which are spread across the river, and intercept its progress sufficiently to render it a mark for various missiles. The St. Lawrence river is a favourite resort of the beluga, where it is regularly hunted, the skin and oil being very valuable, and the flesh being in some esteem when salted.

Another well-known trespasser on the sea is the Dolphin.

The chief peculiarity of this animal is the elongated head, and especially the manner in which the lower jaw is prolonged beyond the upper. Like the Porpoise, it has its teeth interlocking with each other so perfectly, that when the jaws are closed, the blade of a penknife can scarcely be passed between the teeth; sharp, and slightly curved backwards. As there are nearly two hundred teeth in the jaws, the whole apparatus forms a trap from which scarcely any fish is likely to escape.

On looking at these jaws, we may well ask ourselves the reason why they differ so much in shape from those of the Porpoise, although they are evidently intended for the same object. The reason is evident when we inquire into the manner in which it feeds.

Like the Porpoise, it is fond of pursuing shoals of fish whenever it can find them. But its principal food consists of various flat fish. These creatures, as all know who have visited any large aquarium, generally lie flat on the sand, with their heads a little raised above it, and their bodies often covered with a thin layer of sand which has been raised while the fish is settling down. The rounded jaws of the Porpoise would find great difficulty in capturing one of these fish; but the Dolphin, when it sees a sole, a plaice, or similar fish lying on its sandy bed, shoots rapidly towards it, drives its long under-jaw beneath it, and so scoops it up before it has time to escape. It is remarkable that some of the diving birds use their beaks in exactly the same manner.

One of the strangest of these animals is the Narwhal,

in which the development of the teeth is extraordinary, and, at present, unexplained.

Both sexes have in youth a few teeth which soon fall out, but in the upper-jaw of the male are two teeth which are capable of enormous development. In the female these teeth, or tusks, as they may be called, remain, as a rule, undeveloped, and are not seen externally; but in the male, one of them, usually the left, is developed into a long horn-like tusk, sometimes reaching to the length of ten feet, and containing an enormous mass of ivory.

The power of the animal may be inferred by lifting one of these large horns, which, as the animal seldom exceeds twelve or thirteen feet in length, is very nearly as long as itself. The tusks are supposed to be developments of the canine teeth. They are smooth externally, gradually tapering, and spirally grooved in so perfect a manner that they seem to be beautifully carved in the lathe. The ivory is of good quality.

The question now arises, What can be the use of the tusk, and how can it aid the animal in its course of life? This question is at present unsettled, and it is not easy to frame any hypothesis which will account for it.

Some persons have thought that it was used in order to pierce the fish on which it feeds, much after the same manner that the saw-fish dashes among its prey, and disables them with its tremendous beak before seizing them in its mouth. If both sexes of the narwhal were armed with the horn, as both sexes of the saw-fish are armed with a beak, this theory might have some grounds of probability.

But, inasmuch as only the male possesses the horn, and the female needs food quite as much as the other sex, it is evident that she would die of starvation if the horn were necessary in procuring food. Another theory is, that when the narwhal gets below an ice-field, and wishes to breathe, it bores holes through the ice with its horn. But this theory is open to the same objection as the former, the females wanting to breathe as well as the males, and yet having no horn. Moreover, I do not think that any narwhal could drive its tusk through the enormously thick and hard-frozen ice of the Northern waters in which it lives. It would be much more likely to break the tusk than to pierce the ice.

No use has been observed for this extraordinary appendage, but the very fact that it exists is a proof that it must serve some definite and important purpose. It has already been mentioned that, as a rule, only one tusk is developed. Several specimens have been discovered, in which both have been developed. It is remarkable that in each case the animal was a female.

A very remarkable instance of a mammalian Water Trespasser occurs in India. It inhabits the Ganges, and is called the Susue, or Soosoo (*Platanista Gangetica*). Perhaps the reader may remember that the same river is also inhabited by a peculiar crocodile, which has a very long, narrow snout, widened and flattened at the end. The susue imitates this lizard in the most singular manner. Like the crocodile, the susue has a very long and narrow snout, on account of which some zoologists have called it *Delphinus rostratus*.

It also imitates the crocodile in its habits. The lizards are remarkable for their singular alternations between absolutely sluggish apathy and the wildest excitement. Perhaps my readers may remember the character of Mrs. Leslie in Lord Lytton's "My Novel." The worthy lady was descended from two ancient families, the Saxon Daudlers, of Daudle Place, and the Norman Montfydgets, and inherited the "musing do-nothingness of the Daudlers, and the reckless have-at-everythingness of the Montfydgets."

Now, this is exactly the reptilian character. As a rule, a reptile will lie or stand for hours, without moving a muscle, but, if excited, will fly about with such speed that the eye can scarcely follow its movements. It is, however, very remarkable that an aquatic mammal should so closely resemble the aquatic lizard of the same river, and that the two are marvellously similar both in form and constitution.

When we mention the word Siren, the reader must not imagine that there is any connection between the Sirens of zoology and the sweet-voiced sirens of mythology, who inveigled sailors to the shore by their melody and beauty, and then treacherously devoured them. The Sirens of zoology are large, unwieldy, thick-skinned mammalia, which inhabit the brackish waters of tidal rivers, and have not the least claim to beauty of any kind.

Like the whales, the fore limbs are modified into flippers, and with their aid the animal can raise itself partly out of the water, though it is not able to venture entirely upon land. It has a curious habit of coming

to the river-bank, raising itself by means of the flippers, and resting with the head and upper part of the body on the shore, while the rest is in the water.

Having somewhat of the whale tribe in their general form, they have little of the whale's habits. In the first place, they are vegetable feeders, living almost entirely on sea-weed and such like vegetation. Consequently, they are obliged to remain close to the land, whereas the whales are uneasy unless they are at some distance from it.

The structure of the teeth is also different, as they are intended for the mastication of vegetable food, and not for the capture of living animals. There is a distinction between the character of the teeth, the animals having incisors in both jaws, one molar in the upper side of the upper jaw, but no canines; whereas in the porpoise and dolphin, all the teeth look like canines, and, indeed, are used for the same purpose—namely, securing the prey.

Respiration and circulation are in the Sirens different from the same functions in the whales. Living in comparatively shallow waters, and feeding upon a vegetation that never grows at any great depth, the animal does not require to possess the power of remaining under water for any lengthened period.

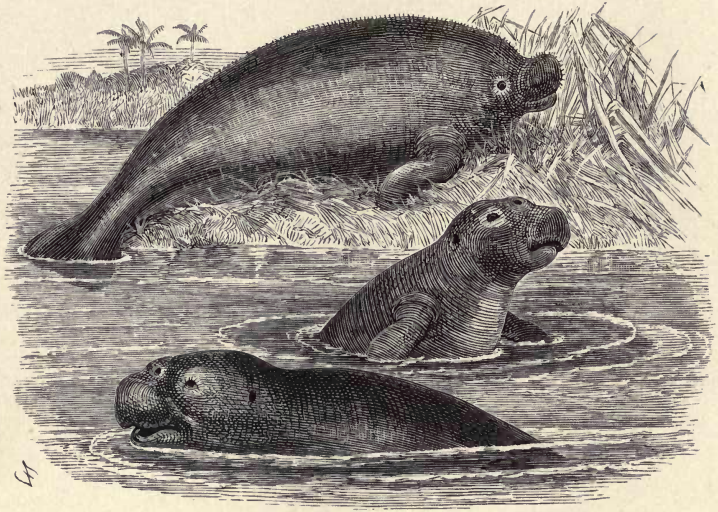
Consequently, it does not possess the great subsidiary mass of blood-vessels which play so important a part in the economy of the whale, and the nostrils are placed at the end of the muzzle, like those of most mammals. The peculiar "blowing" of the whale tribe is not found in the Sirens, as they are not obliged to aërate the vast supply of blood which is needful in

order to keep the whales from being drowned during their long sojourn beneath the water.

Such are the general characteristics of these remarkable animals, and it only remains to give examples of them.

The first is the Dugong, which is represented in the lower part of the illustration on Cut 2. There are several species of this animal, the longest being known to reach the length of twenty-six feet, though the average length is only about eight feet. These animals are found in the rivers that run into the Indian seas, where they may be seen in numbers, feeding on the algæ at the bottom of the river, and every now and then coming to the surface to breathe. When feeding, the Dugong has been observed to seize the plants with its singularly shaped jaws, the upper of which considerably overhangs the lower, drag them from their attachments, and then quietly eat them at the surface of the water. In consequence of the general structure and the vegetable-feeding habits, some zoologists have considered the Siren as the aquatic type of the pachydermatous animals.

The natives of Australasia prize the Dugong almost beyond the power of expression. They use the layer of fat which lies just under the skin as a cosmetic, with which they plentifully besmear the whole of their bodies. As to the flesh, it is perhaps the greatest dainty which an Australian savage knows. He will make a journey of several days in order to partake of it, caring very little whether the meat be fresh or far gone in putrefaction; and, after every available morsel has been eaten, his memory always recalls him



CUT 2.—MANATEE AND DUGONG.

to the remembrance of the feast, and affords him a subject of conversation.

As is the case with most of these animals, the skin is very thick and tough, and can be manufactured into various articles.

Much the same can be said of the Manatees, one of which is represented in the upper portion of the illustration. There are several species which inhabit South America and Africa, the former being the best known. The average length is nine or ten feet. Like the Dugong, the Manatees are useful to mankind, furnishing excellent food, a delicate oil, and a very tough skin that is invaluable for many purposes.

In consequence of its value, and of the necessity for inhabiting the shallow waters, where it must be within easy reach of man, it is greatly persecuted, and even now its numbers are sensibly diminished.

It is much to be feared, indeed, that these singular beings, which form a link between existing and fossil mammalia, may be, before very long, as utterly extinct as the dodo and the great auk, and from the same reason—*i.e.*, their helplessness to protect themselves from mankind. Indeed, one species, the Rytina, has been erased from the earth almost within the memory of living men. It was discovered on an island in Behring's Straits in 1741, and in 1768 not a single specimen was left alive. It was an enormous animal, quite as bulky as a full-sized elephant, though not of the same shape, for its average length was some twenty-five feet, and its thickness rather more than eight feet. If the reader will measure off twenty feet in length on the side of a room, and place

a mark at eight feet in height, he can appreciate the gigantic size of this trespasser upon the domain of water.

It is rather a remarkable fact that the Rytina did not possess any true teeth, those organs being modified into two bony plates, one in each jaw.

CHAPTER IV.

SEALS.

Having now given this brief sketch of those mammalian water trespassers which pass the whole of their lives in the water, we proceed to those mammalia which pass the greater part of their life in the water, procure their food in it, and fly to it for safety, though they produce and nurture their young on the shore.

These animals we know by the popular name of Seals, scientifically termed Phocidæ. They are distributed over the greater part of the world, and are never found at any distance from the shore. They cannot be called amphibious—that being a term, indeed, to which no creature can fairly lay a claim.

But in one respect they are superior to the whale—namely, that although they procure their food in the water, they are capable of leaving that element for the land, and progressing upon it. Moreover, they are able to live on the shore, many specimens having been kept for years far away from the sea, and without having even access to water in which to disport themselves. No whale could live for any time under such circumstances, and when one of these huge animals is driven ashore, it soon dies of hunger.

The method in which the structure of the body is

modified, so as to allow the Seal a perfect freedom of action in the water and a tolerable power of locomotion on land, is very beautiful.

The fore limbs are much more developed than those of the whale, and project so far from the body that they can serve the double purpose of fins and feet. With their aid the animal can scramble along upon land, or even ice, and there are some species which are fond of climbing rocks, and will ascend to a considerable height.

How such apparently clumsy limbs can be used with such effect seems almost incredible. Yet I have often seen the sea-bear climb a high pair of wooden steps, sit comfortably on the top, and then descend with perfect ease. It also clambered on a common Windsor chair, stood on the back, supported by its master's hand, and went through a variety of performances by his orders.

To see the creature mount the chair was really a remarkable sight. First, it raised itself up on its hinder feet, with its fore feet resting on the chair, one on the seat and the other on the back. It then contrived to jerk one of the hind feet on the seat of the chair, and slowly pulled itself up. When it wished to climb on the back of the chair, it took advantage of its master's hand, until it could get both feet on the back, when it placed its fore paws on his shoulders, and looked out for the little piece of raw fish with which it was always rewarded when it had accomplished a task properly. As to the steps, the Seal scrambled up and down them with perfect ease and considerable speed.

These performances are the more wonderful because the long limbs of the Seal are so feeble in comparison with the size of the body that they bend under its weight, and the animal is compelled to advance by swinging the legs under it by way of making steps, and at the same time swaying its body from side to side so as to allow the legs to pass beneath.

Judging from its slow and awkward movements when it is not hurried, a Seal when on land appears as if it could not proceed at any great pace, and, indeed, it looks so helpless that progression appears to be absolutely painful as well as difficult. But when it is actuated by fear, anger, or expectation, it can propel itself at a wonderful rate. This it does by a series of rapid leaps, the body undulating violently, and looking like a large fat caterpillar working its way along.

The body is never raised more than a few inches from the ground during these leaps, but the rate of speed is very great, as is often experienced by hunters who have surprised a party of Seals on shore, and are trying to intercept them in their passage towards the water, to which they rush at the least alarm. Should the beach be a stony one, the pebbles are flung back in showers by the action of the hind feet, so that the course of the pursuers is often materially checked by them. The missiles are not, however, flung intentionally, as some persons have thought, but are thrown by the natural action of the animal, just as a horse at full gallop flings mud or stones from its hind feet.

Any one who wishes to see the curious galloping movement of the Seal has only to go to the Zoological

Gardens, and induce the keeper to bring some fish. The intelligent animals know his step as well as possible, and as soon as they hear it will scuttle over the pavement of their enclosure, plump themselves into the water, shoot themselves out on the opposite side, and raise themselves against the bars, anxiously expecting the food. He will then fling a fish to the opposite side of the enclosure, whereupon the animals gallop along as has been described, race for the fish, and then come back for more, the same gallop and scramble being repeated each time, and the Seals appearing to enjoy the game as much as if they were children scrambling for sweetmeats.

That the gallop is the only way by which a seal can proceed on land with any rapidity, is evident from the structure. The reader will remember that in the whale the hind limbs are entirely absent, so as to leave the body free and flexible, and that there is not even a pelvis. Now, the Seal has to move about on the land as well as to be active in the water, and these two conditions are fulfilled in a very simple manner.

It is evident that there must be hind limbs, and that, therefore, there must be a pelvis to which the limbs can be attached. But the pelvis is very small, as the animal does not need to support the weight of the body upon the limbs, and it is set so far back that the body is as flexible as that of the whales or the dolphins. The limbs themselves are short, but the actual feet are rather long, flat, and set vertically, like the tail of a fish, the functions of which, indeed, they perform.

The long toes are connected with skin, like the webbed feet of a duck, and when the Seal wishes to

propel itself with speed through the water, it presses the hind feet together so as to form them into a single paddle, and, by swaying the body sharply from side to side, propels itself through the water just as a man "sculls" a boat with a single oar at the stern.

I once took advantage of this mode of propulsion—perhaps rather an unfair one. Many years ago I had obtained permission to go with a party of friends to fish in the great Swindon reservoir. We were received by a surly keeper, who would not let us fish from the bank, but put us into a punt, rowed us to an old barge that was anchored in the middle of the reservoir, and then rowed off again, leaving us prisoners until he chose to release us.

When he was out of sight I first thought of cutting the rope, and swimming ashore with the barge, but presently hit upon a much better plan. We took the butt-joints of our fishing rods, put them into the holes of the capstan, and succeeded in getting up the anchor. We then shifted the rods to the rudder and used them by way of a tiller, that article, as well as oars, poles, etc., having been carefully removed.

By working the rudder backwards and forwards we soon got the barge into movement, and traversed the whole of the reservoir at will, visiting various islets, and procuring the eggs of coots and other water birds. At last, we took the barge to the furthest end of the reservoir, got ashore, and then pushed the barge back into the water.

The keeper's rage was unbounded when we presented ourselves at the door of the enclosure, he thinking that we were prisoners all the while, and not

having the least intention of releasing us for some time. Nor was his anger appeased when we declined to give any explanation as to the mode of our escape.

I mention this incident in order to illustrate the propulsive power of a Seal's hind feet. For, even under such disadvantageous circumstances, the rudder being very small in proportion to the barge, and having to be worked very slowly and cautiously for fear of breaking the fishing-rod which acted as a tiller, we traversed a course of several miles, and guided the unwieldy vessel just as we liked.

Now, the paddles, or hind feet of the Seal are very large in proportion to the size of the animal, and are swept backwards and forwards with the whole force of the powerful and flexible body. A single slow and gentle sweep of the paddles drives the animal for a wonderful distance through the water, while a powerful stroke gives sufficient impetus to send the Seal fairly out of the water. The fore paws are principally used for preserving the balance and inclining the body from side to side. One of the Seals in the Zoological Gardens used habitually to swim on its back, like the well-known water-boatman of our ponds.

As the Seals spend so much of their time in the water, it is evident that, like the whale tribe, they should have a sort of blanket in order to preserve the heat of the body. This object is attained by two methods.

In the first place, there is a layer of fat beneath the skin, somewhat like that of the whales, but separate from the skin and not entangled in it. In the next place, there is a covering of hair outside the skin:

this covering is two-fold. Next the skin comes a coat of thick, soft, downy fur, which in some species is so fine, glossy, and warm, that it is of great value in the fur trade. The seal-skin jackets, mantles, and muffs, which are so favoured by ladies, are formed of this inner coating.

Next comes an outer coating of long and rather coarse hairs, which project through the down and are laid as closely together as the thatch of a house, and are quite as impervious to water. They are all set with a decided slope backward, so as to offer scarcely any resistance to the water when the Seal is swimming. These hairs are too thick and coarse for civilized wear, though the Greenlanders and Esquimaux are only too glad to make use of a double protection against the cold. In order, therefore, to suit the present taste, the coarse hairs must be plucked out by hand, and this process adds in no small degree to the cost of the fur.

It is remarkable, by the way, that the extinct Siberian elephant, popularly known as the Mammoth, had just such an arrangement of fur and hair. Next the skin was a thick coat of fur, the hairs of which were about an inch and a half in length, and over them came a thatch, so to speak, of very coarse hairs, varying greatly in length, but evidently intended to shield the animal from wet as well as to retain the bodily heat. The colour of both kinds of hair is reddish brown, the fur being of a warmer hue than the coarse hairs. Beside these, there was a further protection afforded by a number of very thick hairs, or rather bristles, fully eighteen inches in length. I believe that these

are for the purpose of straining off the water, and conducting it so as to fall in streams away from the animal's body.

The reader may be reminded that the long hairs of the great apes are used for a similar purpose. Those of the upper arm are directed downwards, and those of the lower arm upwards, so that they meet at the elbow in a sort of point. When rain comes on, the animal sits crouching together as closely as possible, with its arms crossed and the hands resting on the shoulders. The arms then act as a penthouse for the rest of the body, the water running down them and pouring off the long hairs at the elbow.

As is the case with the whales, the external orifice of the ear is exceedingly small, so that the water cannot penetrate into the auditory apparatus. The lungs are similarly guarded by means of the structure of the nostrils, which are self-closed by their own elasticity, and are held tighter together in proportion to the pressure of water.

It has been mentioned that the Seals produce their young on the shore, or, at all events, out of the water, thus differing essentially from the whale tribe, which are unable to leave the water, even for a short space of time.

Sometimes the Seals proceed a little inland for this purpose, and sometimes they remain upon the ice, their two-fold coating of hair outside the skin, and their single, but thick, coating of fat inside it, effectually enabling them to endure contact with its cold surface. A most remarkable history of the nursery life of a Seal is given by Capt. Hall in his "Life among the Esquimaux."

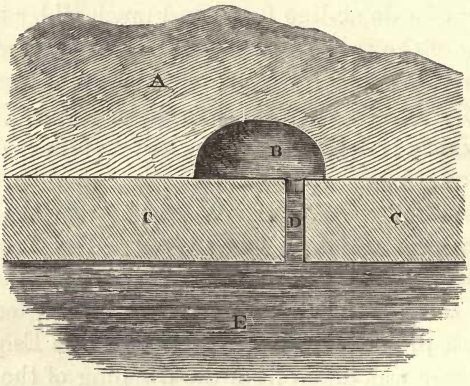
It appears that in that region the Seals always keep open breathing-holes for themselves, which they contrive to pierce completely through the thick ice. This is done by always resorting to the same spot when the ice begins to form, so that at last a perpendicular tunnel is always kept open, and is large enough for a full-grown Seal to pass up and down with perfect ease.

As the time approaches for the young one to be born, the mother ascends the tunnel, and with her fore paws scrapes away the snow until she has formed a cavity of a dome-like form, and much wider than the opening of the tunnel. She is enabled to ascend the tunnel easily enough, because the weight of the ice and snow forces the water almost to its entrance. On the ledge which is left around the entrance she deposits her young one, which is thus nurtured in almost absolute safety—the bear, fox, and the dog being the only enemies which it has to fear. The Esquimaux call these remarkable houses by the name which they give to their own snow-houses, namely, "igloo," and it is most probable that the first idea of the Esquimaux snow-house was taken from the dwelling of the Seal.

Within this house the young Seal remains for some time. Gradually, summer comes on; the rays of the sun melt away the snow that lay upon the roof of the igloo. But, by this time, the young Seal has so increased in size and strength that it no longer needs the protection, and is able to shift for itself.

A rough plan or chart of the Seal's igloo is here given. It is taken from Capt. Hall's description. A represents the snow; B is the igloo scraped in it; C is the ice; and D is the tunnel, nearly filled with water

by the pressure of the ice and snow; E is the sea on which the ice-floe is resting. The reader will see from this rough chart what a simple, and yet what an efficient, plan this is for enabling the young Seal to be nurtured in safety, and the mother to visit it whenever she likes, and to procure food without betraying the position of her nursling to the many terrestrial foes which would at once render her childless if they discovered the hiding-place of her young one.



SEAL'S IGLOO.

A good account of the Seal's igloo is given by Capt. Hall. A cry was raised that one of the Esquimaux women had caught a young Seal. Everyone ran to the spot, the capture of a Seal being a most momentous event among these people.

"On reaching the place of capture, we found that Tunukderlien had beneath her feet a young Seal, alive and kicking. Koojesse immediately made a line fast

to one of its hind flippers, and allowed the Seal to re-enter the igloo where it had been caught.

"As this was something new and interesting to me, I intently watched what followed. The Seal was, perhaps, two or three weeks old, and, like all young Seals, was white, though not so white as untainted snow.

"While Koojesse kept hold of the line, four or five fathoms long, the Seal worked itself hastily back into the igloo, its birth-place, where it made a plunge down the seal-hole into the sea. Koojesse allowed it the whole play of his line, crawling into the igloo, taking the seal-hook with him, and waiting patiently for the parent Seal to come up. I was close by him, there being just sufficient room through the opening made where the young Seal was caught for me to push myself in. Then, lying flat down, we both carefully watched.

"In three or four minutes the young Seal returned, popping up its round, shining head, and blowing and puffing like a whale, though on a reduced scale, its large eyes glistening like lights from twinkling stars. It came directly to its bed-place, where we reclined. As it attempted to crawl up, Koojesse gave it a stroke on the head, signifying, 'Go away—dive down—show to your mother that you, the darling of her affections, are in trouble; and when she comes to your aid I'll hook her too!'

"The two women were now close by us, each with a seal-dog, and, while waiting, I had a good opportunity of inspecting a Seal's igloo.

"It was a model of those which the Innuits make for themselves, and was completely dome-shaped. It

was five feet or so in diameter, and two-and-a-half feet high, with a depth of snow above it of some five feet. The platform of sea-ice was where the parent Seal gave birth to its young, and afterwards nursed it. On one side was the seal-hole, filled with sea-water, which was within two inches of the top of the platform."

In all probability, the igloo is retained in its shape by the animal warmth and hot breath of the young. We shall return to the Seal's igloo when we come to treat of the polar bear as a trespasser. The little animal which was thus used as a bait wherewith to catch its mother, was afterwards killed in the usual fashion—*i.e.*, pressing it strongly on the back with the whole weight of the body, and so stopping its breath. This is done for the purpose of saving the blood, which, when drunk warm, is one of the greatest luxuries of the Esquimaux, and even appreciated by Capt. Hall himself.

See how many laws of Nature are utilized to preserve the life of a baby Seal.

First, there is the fact that water, when frozen, expands in size, and therefore floats upon the yet unfrozen water. Did it contract instead of expanding, the whole of both polar seas would have been by this time nothing but a solid mass of ice. If the ice had sunk instead of floated, it would have congealed the water around it, and so added to its bulk as well as to its weight. Nor would it ever have been thawed again.

Water is a very bad conductor of heat; so bad, indeed, that if a vessel be filled with water at thirty-four degrees, and a red-hot lump of iron plunged

into it for an inch or so, the water around the iron will be boiling fiercely, while at a couple of inches below the iron it will still remain at thirty-four degrees.

As far as the Seal goes, two points are already gained in its favour. The ice floating on the surface of the water acts as a safeguard; for it is just as difficult for heat to get through ice in one direction as in another; and, however cold the external atmosphere may be, it can but slowly extract the heat through the covering of ice, which serves in the inanimate world the same purpose that the fatty "blanket" serves in the living whales and seals. Next, by means of this layer of ice interposed between the sea and the open air, the water is preserved unfrozen; and so the Seal can always find the supply of fish on which its life, together with that of its young, depends.

The same quality of flotation in the ice is also utilized in supplying the infant Seal with a couch on which it can lie until it is strong enough to enter the water and shift for itself.

Again, the peculiar crystalline formation of the snow is utilized in providing a shelter for the little animal. It is light enough to be easily scooped away by the fore paws of the mother Seal. Yet the ramified form of the crystals, which interlace each other in all directions, render it tenacious enough for the igloo to preserve its form, instead of falling in, as would be the case if it were sculptured in sand. And, lastly, it is partially pervious both to light and air, so that the young Seal is not altogether deprived of these accessories to life.

Another law of Nature is then brought into play. If the superincumbent weight of the ice and snow were to produce no mechanical effect on the water on which it floats, the mother Seal would have great difficulty in ascending the tunnel, if, indeed, she did not find it impossible. But the pressure forces the water to such a height, that the animal can rise nearly to the surface of the ice, and can easily scramble to the assistance of her offspring.

Thus we see how the same property of matter—*i.e.*, a slow conducting of heat, can be employed for the use of the same animal in three different ways. Directly applied to itself in the way of the fatty layer beneath the skin and the coating of fur outside the body, it prevents the animal heat from escaping into the surrounding water, ice, and cold atmosphere. Indirectly applied, in the form of snow and ice, it preserves the sea from being wholly frozen; and in the form of snow, it affords to the young Seal a warm residence.

It is well known that owing to the non-conducting power of snow, the snow-house of the Esquimaux is not only warm, but so hot, that although it is only warmed by the lamp, the inhabitants are often obliged to throw off all their clothes. Indeed, were it not for this property, the Esquimaux could not sustain existence. In their country no tree can grow, and there is absolutely nothing with which the inhabitants can build a house, except the snow. This, however, is always at hand; and so, where an European would speedily lose his life by the frost, the Esquimaux finds a warm and comfortable refuge from the cold. Experienced travellers in cold climates have long known

that if they are benighted at a distance from shelter, they can make themselves tolerably comfortable, provided that there be only a reasonable depth of snow into which they can burrow. And this very property is utilized by the Seal, which, like the human inhabitants of the same land, finds a shelter and a home beneath the ice-cold snow.

Having thus seen how the structure of the Seals is modified according to the surrounding conditions, and enables them to divide their lives between the land and water, we will briefly notice one or two of the most conspicuous species, and see how their habits agree with their structure.

The Common Seal (*Phoca vitulina*) is too familiar to need description, and we will therefore proceed at once to the two species which are represented on Plate I.

The figures in the foreground represent the Walrus, an enormous species of Seal, measuring, when adult, no less than fifteen feet in length; and being, as may be seen by reference to the illustration, very stout in the body.

On looking at the Walrus, the first point that strikes the observer is the enormous development of the canine teeth of the upper jaw, which form two long and powerful tusks, slightly curved, and gradually tapering to a point at the tip.

The reader may remember that in the description of the narwhal, a doubt was expressed as to the purpose served by the one enormous tooth that projects from the jaw of the male. The chief difficulty lies in the

fact that only the male possesses this tusk; so that it could not be used for the purpose of gaining food, or, indeed, of preserving life in any direct manner.

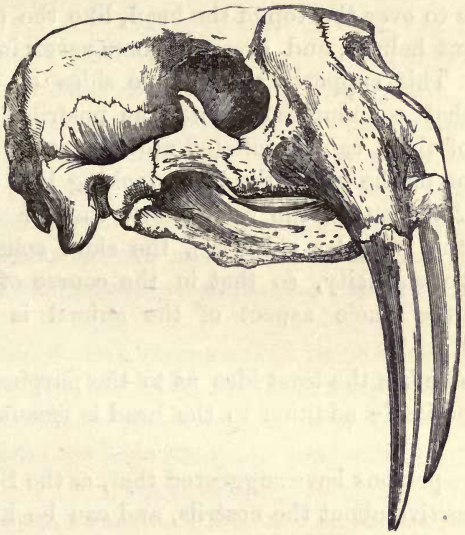
In the Walrus, however, both sexes possess the tusks; so that no such difficulty arises. One use to which these enormous tusks are put, is to aid the animal in dragging its huge body upon the shore. Another use is, to tear up the algæ which grow upon the rocks below water-mark: for this Seal is omnivorous, and, besides eating fish, crustacea, and other animal substances, feeds also upon the marine vegetation.

The tusks are larger in the males than in the females, and are used on occasions either when they fight with each other, or when they are engaged in defence against other enemies. The worst of them is the Polar bear, which, however, is often beaten off by a powerful male Walrus, though the skin of the latter shows many deep wounds caused by his enemy's claws.

When they fight among themselves, it is almost invariably in the breeding season. Each male has quite a harem of females, over whom he watches with the extremest jealousy, though he does not lose an opportunity for decoying a member of a neighbouring harem into his own premises.

The very peculiar shape of the muzzle is caused by the very large bony sockets which are needed for the reception of the huge tusks. These sockets extend nearly to the upper part of the head, and are so long that when the mouth is closed, the lower part of the socket is about level with the bottom of the lower jaw.

The accompanying illustration, which is kindly lent by Messrs. Routledge and Sons, shows the remarkable form which both jaws are obliged to assume in order to accommodate those enormous tusks. This jaw, if formed in the usual manner, would be in the way of tusks, so that the mouth could not be closed. It is,



SKULL OF WALRUS.

therefore, very much narrowed in front, so that it passes easily between the tusks, and can move with freedom.

Another strange variation in the structure of these animals is shown in the centre of Plate I., the figures in which represent that extraordinary creature, the

Crested Seal (*Stemmatopus crestatus*), so called on account of the upper part of the head, which in the male is developed into a sort of crest, that can be raised or lowered at pleasure. It is, in fact, a modification of the nose, and constructed in a singular manner.

An upright ridge of gristly substance passes from the nose to over the top of the head, like the crest of an ancient helmet, and averages some seven inches in height. This supports the flexible sides of a large pouch that communicates with the nostrils, and by means of them can be inflated until it forms a large projection on the top of the head, looking like a huge wen. As soon as the Seal allows the air to pass out of this singular structure, the sides collapse by their own elasticity, so that in the course of a few seconds the whole aspect of the animal is totally changed.

No one has the least idea as to the purpose which this remarkable addition to the head is meant to perform.

Some persons have suggested that, as the Seals are very sensitive about the nostrils, and can be killed by a comparatively slight blow at the end of the nose, the inflatable sac is intended to protect the animal's life. This object it certainly does fulfil, but I cannot think that it was designed for any such purpose.

In the first place, Seals were not made for the purpose of being knocked on the nose; and in the next place, there can be no reason why the females and immature males should not be endowed with the same protective armour, their fur being quite as saleable as

that of the adult male, and they, in consequence, being equally liable to be knocked on the nose.

It has also been suggested that the sac is intended to increase the loudness of the voice; but the fact that it communicates with the nostrils, which are used for breathing, and not with the throat, which is used for the production of sound, militates strongly against this theory. All known species of Seal can bellow loudly enough when they are angry, but they do so with their throats, and not through their noses.

An appendage of an equally mysterious character belongs to the gigantic seal, which is called the Sea Elephant (*Morunga proboscidea*). The name is doubly appropriate, the animal being of gigantic dimensions, and the snout of the adult male prolonged into a form that somewhat resembles the proboscis of the elephant.

Even the Walrus looks small in point of size by the side of the Sea Elephant, the former averaging some fourteen or fifteen feet in length, while an adult male Sea Elephant has been known to measure thirty feet in length.

The enormous snout of the male is, in one respect, like the head-pouch of the Crested Seal. When the animal is undisturbed, it hangs down quite loose and flaccid, and is scarcely noticeable at a little distance. But when it is angered, especially by a rival of its own species, it has a way of expanding the proboscis to a wonderful size, thereby giving itself a most formidable aspect.

Its enormous dimensions, and the powerful teeth with which its jaws are armed, render it a very un-

pleasant looking animal, but the additional feature of the expanded proboscis gives it a look of ferocity which is quite appalling. Fortunately for its human enemies, its terrors evaporate in mere show, for, if boldly faced, it will shuffle off as fast as is permitted by its huge, fat, oil-clad body, which quivers like a shape of jelly as it moves along.

We naturally ask ourselves the use of these singular appendages to the Crested Seal and the Sea Elephant. We do not as yet know, any more than we know the object of the long mane-like hair upon the head, neck, and shoulders of the Seal called the Sea Lion. It derives this name partly from the mane, which gives it a lion-like aspect, and partly from its habit of almost perpetually roaring when on shore. This habit, by the way, has more than once been of the greatest use to sailors, by warning them of the vicinity of land or an ice-floe which they were approaching too closely in foggy weather.

Even with our own species, we do not understand the use of many of the structures. Take, for example, a parallel case, the beard of man, which is analogous to the head-pouch of the Crested Seal, the dilated snout of the Sea Elephant, and the mane of the Sea Lion. It serves no definite purpose, as far as we know. It cannot be intended, as some have said, for protection against cold, because while the Hindoos, who live in a hot climate, have very large stiff beards, the Esquimaux of the Northern Polar regions, and the Fuegians of the Southern Pole, are devoid of any such protection, their faces being practically beardless, as far as defensive purposes are concerned.

Again, we have two distinct races of men inhabiting contiguous localities, in which the one is bearded and the other beardless: these are the Fijians and the Tongans. The former are magnificent creatures, with vast quantities of long and curly hair on their heads, and their faces covered with the fullest and most luxuriant of beards. The latter have long and straight hair on their heads, and their faces are nearly as smooth as those of women. Yet they live under the same skies, have many of the same habits, and feed on the same food.

And it is a curious fact that the fierce-looking Fijian, who is always crying for war, who never walks without a club on his shoulder, and is a confirmed cannibal, is hopelessly overmatched by the quiet, mild-looking, beardless Tongan, who, indeed, has made inroads upon the Fijian coast, and threatened to establish himself permanently there, despite all efforts of the externally valiant, but at heart cowardly Fijian, to expel him.

CHAPTER V.

Reptilian Water Trespassers.

Among the reptiles there are so many water trespassers that it is difficult to determine the species with which to begin, especially as there are some beings which occupy so closely the boundary line between reptiles and fishes, that it is not easy to fix their exact place. Again, the reptiles being divided into two distinct portions—the one of which is represented by the frogs, toads, and newts, while the other consists of lizards, tortoises, and serpents—we find ourselves in some confusion as to their precedence.

The best plan is, as I think, to take those creatures first which, like the seals among the mammalia, pass almost the whole of their lives in the water, although they are capable of living upon land. Familiar examples of the most perfect form of these creatures may be found in our Common Frog and Newt, which, however, unlike each other externally, are constructed exactly on the same model as regards their power of water trespassing, and differ chiefly in their mode of propulsion, whether in water or on land.

It is evident, for example, that the Newt, which

passes by far the greatest part of its time in the water, should be formed on a more fish-like model than is needful for the Frog, which passes the greater part of its time on the land, though the water is a perfectly familiar element to it, and it can propel itself nearly as fast, though not so gracefully, as does the Newt, the one advancing by a series of intermittent strokes from the webbed hind feet, while the other undulates rapidly and steadily, after the manner of the fish, being propelled by the sinuous movement of the flattened and flexible body.

We will begin with the Newt, as an example of a water trespasser which passes most of its time in the water, though it can live and travel upon land.

One of these singularly pretty creatures is represented in the central figure upon Cut 3. In common with the Frog and Toad, both of which are seen upon the same illustration, it begins its active life as a fish, carrying on respiration by means of gills, and ends it as a reptile that breathes atmospheric air by means of lungs. So that we have before our eyes one of the most astonishing arcana of Nature, examples of which may be found any day by any one who will take the trouble to look for them. As the space of this work is but limited, it will be necessary to give but a very brief description of this remarkable modification of structure, as exemplified in the Newts, Frogs, and Toads.

The egg is deposited in the water, like that of a fish, and when the young is hatched it has gills constructed on precisely the same plan as those of the fish, except that they are outside instead of inside the head,

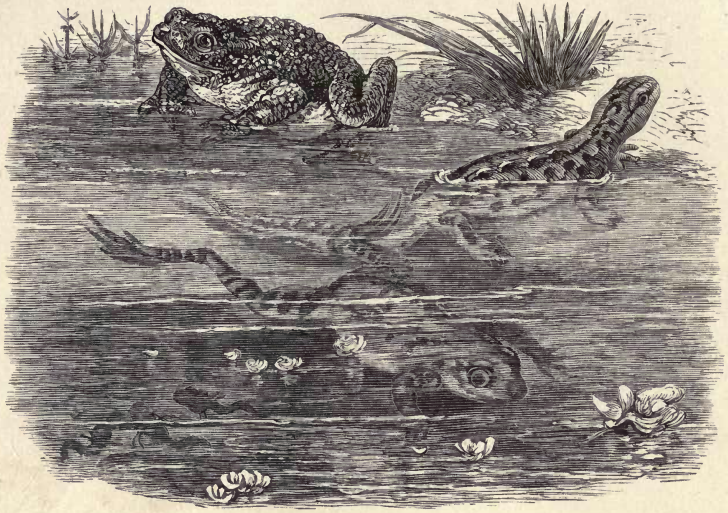
looking like little pink feathers attached to the sides of the neck, the pink colour being due to the blood which is seen through their delicate membranes. In this state, the young animal is well-known under the name of tadpole, and I very strongly advise my readers who are within reach of a pond or ditch, to catch some tadpoles and examine them with the magnifying-glass. Whether they be the young of Newt, Frog, or Toad, does not in the least signify.

In this form, they remain in the water for some three weeks, during which time the limbs are beginning to show themselves, and the lungs are being gradually developed. Taking the Newt as our first example, it retains through life the elongated and fish-like shape of the body, and takes, in addition, four legs, which are short, not very strong, but quite capable of enabling their owner to walk upon land.

Another great and radical change is, however, taking place.

Not only does the animal gain limbs and lungs, but, exactly in proportion to the development of the lungs, the gills begin to become gradually less, until they vanish entirely, and the whole of respiration is conducted by means of the lungs. We have now a reptile which is to its own order what the whales are to the mammals. It lives in the water, finds its food below the surface, and is, therefore, obliged to be able to pass a considerable time without respiration.

This object is achieved in a very simple manner. In the case of the whales and dolphins, which are hot-blooded mammals, so large an amount of oxygen is



CUT 3.—TOAD, NEWT, AND FROG.

required for the aëration of the blood that the animal cannot take with it a supply of air, but substitutes a reservoir of clearly aërated blood. The reptiles, however, being cold-blooded animals, do not require so much oxygen, and, in consequence, they are able to take with them a quantity of air which suffices them for a considerable period.

For this purpose, the lungs are composed of cells very much larger in proportion to the size of the animal than those of the mammalia. Thus, only a portion of the blood is at a time brought into contact with the air within the lungs, and a comparatively small supply can last for a considerable time before its properties are exhausted. As the quantity is so small, the act of respiration can be performed in a very short time; and a Newt which has been below the water for a long time will just wriggle its way to the surface, put its head partly out of the water, take a single quick breath, and then wriggle its way down again, the whole business being transacted in so short a time that if the observer be armed with a net he must be very quick in his movements if he can capture the Newt before it has descended beyond his reach.

Generally all the Salamanders, as these creatures are collectively termed, are of small size; but there are one or two exceptions, the most illustrious of which is the Giant Salamander (*Sieboldia maxima*), of Japan, which is about a yard in length, and very broad in proportion to its width, so that it is really a large animal. It does not possess the beautiful green and orange hues of our own little Newt, but is black-brown, and all covered with warty knobs, so

that it is anything but a pretty creature. It lives well in this country.

Another very large Newt is the Menopome of the Ohio river, which reaches the length of two feet or so. Both these large Newts are very voracious; and are so destructive among fish, that the latter has received the popular but not euphonious names of mud-devil, hell-bender, and ground-puppy.

The fishermen are nearly as much afraid of it as our English peasants are of the Common Newt, though with a little more reason, inasmuch as the Menopome is a large animal; and in spite of the small size of its teeth, might manage to give an ugly bite; whereas the Newt is absolutely incapable of harm. But, in both cases, the animal is credited with powers which it does not possess, and its bite is thought to be venomous.

It does not seem to be very plentiful in any locality, its numbers having apparently been diminished within the last few years. Dr. C. C. Abbott mentions that in various parts of the United States, the Menopome has been exhibited in travelling menageries under the title of the "Australian *Ornithorhynchus paradoxus*." The exhibitor must have possessed wonderful confidence in the ignorance of the general public.

In captivity it is found to feed voraciously on minnows and similar fish, an astonishing number of which it devours daily. One of these reptiles tried to eat a large cray-fish, but got so sharply pricked in the nose by the projecting points of the crustacean's head, that it afterwards took care to let the creature alone.

There are some of these animals which seem to have their development arrested, and never to get beyond the tadpole state. Such, for example, is the well-known *Proteus anguinus* of Adelsberg, in Carniola, a creature in which not only the organs of respiration, but those of sight are undeveloped. It is, in fact, little more than a blind tadpole of full size, having no eyes, and breathing entirely through gills.

Then there is the Axolotl (*Axoloteles guttatus*) of Mexico, which is about eight or ten inches in length. It has anything but a pleasing look, but yet is valued as an article of food, and regularly sold in the markets.

The gills in this creature are very bold and conspicuous, standing out like tufts of feathers on either side of the back of the head.

The strangest thing about this animal is, that although when left in its native waters, it never passes beyond the tadpole condition, it can be artificially developed into the state of a Newt. It is found that if the supply of water be gradually cut off, the gills diminish in proportion to the lessening of their usefulness, while the lungs become developed. In fact, the creature is forced artificially to go through just the same process as the newts, frogs, and toads. undergo naturally.

It may seem strange that these creatures should be undeveloped all their lives, and yet produce young. Such, however, is the case; for they lay eggs just like any other Newt, and their eggs are hatched into little tadpoles, which afterwards grow to be big tadpoles, but never pass beyond that stage.

In the Insect-room at the British Museum, several of these creatures have been kept for some years in a glass vessel. They are quite tame, and will come to be fed when summoned; the mode of calling them being to make a slight rippling on the surface of the water with the finger.

The axolotl breeds freely in England—the specimens in the British Museum producing annually great quantities of young. They are, however, difficult creatures to rear; and only a very small percentage pass even beyond their infancy. I tried to rear a dozen of them, but failed, although I took care to supply them with water in which were great numbers of the water-flea, and other entomostraca. Most of them died gradually off, without having increased in size; while only one seemed to be in the way of thriving. That one did grow finely, and I thought that it would have survived; but one day the usual fatal sign made its appearance, *i.e.*, a sort of flocculence round the body, and in another day all my axolotls were dead.

I much regretted its loss, as I wished, as soon as it was about half-grown, to try the experiment of converting the gill-breathing axolotl into an air-breathing newt.

The axolotl is shown in the lower figure of Cut 4.

There is one very large species of gill-breathing Newt which inhabits the Mississippi and several of the American lakes. Its scientific title is *Necturus lateralis*. I do not know whether it possesses a popular name.

It sometimes reaches a length not very far short of

CUT 4.—SNAKE AND AXOLOTL.

that of the great Japanese Salamander, though it is not so broad and stout. Its gills have a more fan-like form than those of the axolotl; and it is probable that if the experiment were tried, the respiratory apparatus of the Necturus could be artificially developed, like that of the axolotl.

With regard to these gill-breathing Salamanders, Dr. Baird was of the opinion that they were really the arrested form of some animal, which is, at present, unknown in the perfect state. Perhaps some of my readers who take a delight in the aquarium, may remember the pretty little Spotted Salamander or Eft, that is in such demand on account of its violet-black colour, relieved with a row of large, irregular, yellow spots on each side. The scientific name of the animal is *Ambystoma Carolina*, and Dr. Baird considered that the axolotl is in reality the arrested larval form of some Newt belonging to the same genus as the Spotted Eft.

In consequence of the fact that they retain the gills throughout their whole life, the animals which have just been mentioned are collectively termed Perennibranchiate Amphibia, that is, amphibious reptiles whose gills are permanent. The true newts, frogs, and toads are, on the other hand, termed Caducibranchiate Amphibia, *i.e.*, amphibious reptiles whose gills are obliterated.

On these remarkable changes of structure Mr. Rymer Jones has the following remarks :—

"However curious the phenomena attending the development of the tadpoles of the amphibious reptiles may be to the observer who merely watches the changes

perceptible from day to day in their external form, they acquire a tenfold interest to the physiologist who traces the progressive evolution of their internal viscera. More especially, when he finds that in these creatures he has an opportunity afforded him of contemplating, displayed before his eyes, as it were, upon an enlarged scale, those phases of development through which the embryo of every air-breathing vertebrated animal must pass while concealed within the egg.

"The division, therefore, of reptiles into such as undergo a metamorphosis and such as do not, is by no means philosophical, though convenient to the physiologist; for all reptiles undergo a metamorphosis, though not to the same extent."

Mr. Jones then proceeds to sum up the subject by showing that in the Perennibranchiate reptiles the change from the aquatic to the air-breathing animal is never fully accomplished, while in the Caducibranchiates the change takes place after the young has been hatched. He then shows that even in the case of the reptiles proper, such as the lizards, snakes, and tortoises, a similar change takes place, though it is accomplished within the egg, long before the little animal is hatched. And the same rule holds good with birds.

From these observations the reader will, I think, see the extreme value, not only of observation, but of generalizing the facts that are observed.

Even if taken alone, the faculty of observation is of very high value. It adds a new charm to life, and gives entrance, so to speak, into a different world. The good old story of "Eyes and No Eyes" is applicable

to Natural History as well as to general observation, and anyone who is even partially trained to observation will find himself absorbingly interested in a walk where another finds nothing but dull uniformity.

Still, the mere accumulation of facts, though valuable, is not all that is required. It is knowledge, but not wisdom. Taking our present example of the development of the newt, it is a singularly interesting task to watch the gradual development of the tadpole into the newt or frog—to notice the growth of the limbs and the disappearance of the gills. But it is infinitely more interesting when we grasp the fact, that in the development of this creature, which is carried on before our eyes, we have the key to the development of all vertebrated animals, and to note that all pass through similar changes, though not in so open a manner.

It is evident that the generalizer must possess a mind of wider grasp than is needed for observation alone, and it has frequently happened that the person who has hit upon the most valuable generalizations is one whose thoughts are mostly engaged on subjects of a different nature.

Take, for example, the two great discoveries in zoology and botany—namely, the homologies of the skeleton and the structure of the fruit. These discoveries were not made by professed zoologists or botanists, but by Goethe, the poet. He certainly had some knowledge of both these sciences, but he was also deeply read in various forms of literature, and had studied chemistry, jurisprudence, music, drawing, and languages. In this latter branch of knowledge he was

so expert that for his own amusement he wrote a sort of novel, composed of letters written by seven correspondents, each in a different language.

A mind thus trained was sure to see a new fact in various lights, and to grasp at once the relations which it would hold with other facts. No idea ever presents itself alone to such a mind, but is immediately grouped about with other ideas gathered from various sources, but all bearing on that one point.

Now let us see how it happened that a poet discovered the homologies of the skeleton.

He was walking, and saw a skull—I believe of a deer—lying on the ground. There was nothing very noteworthy in this. Thousands of skulls had been examined by professed anatomists, who were familiar with every part of them, and the use of every hollow, projection, or perforation; and yet none of them had detected in the skull its relationship to the rest of the skeleton. It is possible that the very same skull had been seen by many persons, who saw in it nothing more than a familiar object.

To the eye of the poet, the skull was a revelation. It lay with the base towards him, and it suddenly flashed across his mind that the occipital bone was, in fact, nothing but a vertebra modified, the large hole at the base of the skull being an enlargement of the hole in the vertebra through which the spinal cord passes, and the disc-shaped bone itself nothing but the vertebra flattened. The next thought evidently was to the effect that if one part of the skull were a modified vertebra, the other parts had probably the same origin, the hollow of the skull being a still further enlargement of

the vertebral hole, and the dome-like bones nothing but modifications of the vertebra itself. In fact, the skull is not an isolated structure, but is formed of a simple modification of four vertebræ.

On this beautiful discovery, so obscure before it was made, and so simple afterwards, is based the whole of our modern knowledge of the skeleton and its homologies throughout the whole of the mammalia. The subject is far too vast to be discussed in the present work, and I can only refer my readers to Professor Owen's "Lectures on Comparative Anatomy." Suffice it to say that since the time when Goethe saw that stray skull, the vertebra has been known to be the key to the whole skeleton, all other parts being but modifications of it, however unlike they may appear to the uninstructed eye.

The second great discovery of this wonderful man was the structure of fruit, which he found out while eating an orange. I suppose, and certainly hope, that most of my readers have eaten plenty of oranges in their time; but scarcely think that, unless as botanists, they were aware of the fact that the orange contained the key to the structure of the fruit, as the vertebra contains the structure of the skeleton.

Goethe, however, saw with other eyes than most men, and, as he opened the orange, a mystery of Nature was revealed. It is probable, and almost certain, that he had eaten many oranges before this particular one opened the eyes of his understanding. On separating the various segments of which the interior of an orange is composed, he was at once struck with the fact that each segment was in reality a

modified leaf, the outer membranes representing the upper and lower epidermis of the leaf, and the soft, juicy interior being a modification of the "parenchyma," which in some leaves is very thin, but in others is very thick and juicy. The leaves in question are of the kind which are technically called "carpels," and are those of which seed-vessels are made.

He saw in that one intuitive flash of genius that the orange is, in fact, a whorl of leaves, and thus was given the key to a great mystery hitherto concealed from man. By means of this discovery one or two apparent anomalies are easily explained. There is a variety of orange, known by the name of the Female Bigarade. It is a large, coarse, deep yellow fruit, which has the peculiarity of being double, one orange being enclosed within another. Although this fact had been known for many years, no botanists could account for it, and it was left for the poet Goethe to supply the key to the mystery. When this is understood, the structure of the double orange is easily understood. It consists of two whorls of carpels on the same stem, the upper and smaller whorl being consolidated into the central fruit, and the lower and larger whorl encircling it. In some cases, three oranges are found one within the other.

Other curious varieties of the orange tribe are also accounted for in the same manner. For example, there is the Fingered Bigarade, in which the fruit is divided into finger-like globes; the Horned Bigarade, in which the fruit is deeply ribbed, and has its sides projecting into horns; and the enormous Chinese Fingered Citron, in which the fruit is entirely divided into long, finger-

like portions. Before Goethe's discovery, no one could account for these singular varieties of form; but when we know that the fruit is composed of whorls of carpels, there is no difficulty in understanding that in the one case there are successive whorls on the same stem, the larger enclosing the smaller, and that in the latter case the carpels are only partially united to each other, so that they form fingers or horns.

Here, then, we see the incalculable value of the union between the observing and the generalizing mind, the latter utilizing the results of the former, and bringing apparently dissimilar facts to bear upon the one central subject. Newton's discovery of gravitation, or, rather, of universal attraction, was of a precisely similar nature, although the subject is a much larger one. There are still many unsolved mysteries in Nature; and I feel sure that when the "hour and the man" come, they will be solved as simply as Goethe solved the homologies of the skeleton and the structure of fruit, and as Newton discovered that the courses of the heavenly bodies and the falling of a stone to the ground were governed by one and the same law of mutual attraction.

There seems to be an idea that Frogs and Toads can live entirely in the water. This is not the case, for either of these animals will be drowned if placed in water from which it cannot escape. It will drown as certainly as will a dog or a cat, only the operation will occupy a longer time. I well recollect that when I was a small boy I found some frogs in the garden, and thinking them to be in want of water, I filled a pail nearly full and put them in it. I was sorely dis-

concerted one day to find that my pets were dead, and had some difficulty in understanding that a Frog or Toad could be drowned.

There is an artificial bathing-place near where I live. It is a large oblong basin, lined with cement, and so arranged that the water cannot rise within a foot or so of the edge. Towards the end of summer, there are numbers of dead frogs and toads in the basin. They have heedlessly leaped into the water, and not being able to clamber up the side, have been drowned.

It may be that in these cases the death of the animals may be partly owing to hunger; and this brings us to another point in the history of these water trespassers.

In the case of the newts, the creature obtains its food in the water, through which it propels itself by the sinuous movements of its body. Large limbs would therefore be useless, and, in fact, would only be an inconvenience in the water, while they would be of no great use on the land. Whenever the newt goes out of the water, it does not need to hurry itself, and the four slight limbs with which it is furnished are quite sufficient for its purpose.

But the Frogs and Toads are differently constituted. They have to procure their food on the shore, as well as to propel themselves in the water, and it is evident that the whole plan of their locomotive machinery must be entirely changed. Legs are therefore substituted for the tail as means of progression, and the latter is therefore abolished altogether. Another problem now remains—*i.e.*, to form legs which will be equally

capable of rapid progress on the ground; and how admirably this double duty is fulfilled in the legs of the Frog, is evident enough to all who have seen the perfect ease with which the creature moves either on the ground or in the water.

On the land the progress of the Frog is wonderfully like that of the kangaroo, the very long and powerful hind legs being in both animals the means of propulsion, and the short fore legs used principally to support the body when the animal is at rest. In the water the fore legs are not used at all, but kept motionless in front of the breast.

As for the webbed foot which drives the Frog so rapidly through the water, it is formed by a simple extension of the skin between the lengthened toes. If we separate our own fingers widely, we see that at their juncture there is a fold of skin, which, if continued to the tips of the fingers, would give them a strong resemblance to the foot of the Frog. I have seen more than one instance where, in the human being, the hands were webbed nearly half up the fingers.

Lately there have been in the shops some swimming gloves with a piece of waterproof cloth connecting each finger, so as to make them useful organs of propulsion. As, however, the speed in swimming depends more on the legs than on the arms, the instrument should have been attached to the feet, and not to the hands.

The late Captain Morton, R.N., invented a very ingenious plan of increasing the speed of a swimmer. To the sole of each foot was attached a rather thick strip

of wood about two inches wide, and extending along the whole of the foot. On either side was a piece of very thin but strong board, making the whole apparatus about eleven or twelve inches in width. The side pieces were attached by hinges, so that when the feet were drawn forward, they collapsed, and offered no resistance to the water, while they opened out again in making the stroke. Flat pieces of board were also attached to the hands; and by means of this apparatus a wonderful rate of speed could be attained.

Still, ingenious as was the invention, it is infinitely surpassed by the structure of the Frog's hind feet, which have also the advantage of being useful on land, whereas the swimming apparatus just mentioned would render its wearer incapable of advancing ten steps on land.

Another point in the structure of the Frog is the mode of its breathing. It has neither diaphragm nor ribs, and cannot, therefore, respire by means of either the one or the other. It is, however, compensated for their absence by the great development of the throat-bone called os hyoides, and the muscles connected with it. By their action the large throat is converted into a sort of bellows, by means of which air is forced into and drawn out of the lungs. Anyone can see this movement by watching a Frog or a Toad.

In consequence of this structure, added to the large size of the cellular lungs, the fore part of the body is rendered very light, and is the better able to sustain the animal in the water. Like many semi-aquatic creatures, the Frog can float on the surface of the water, or lie on the bed of the pond or stream, the

contraction of the body enabling it to render itself for a time heavier than an equal bulk of water.

We will now revert to our water trespassers, and take one of the most perfect of the lizard trespassers, namely, the Crocodile, with which the Alligator will be included. There is really but little difference between these two groups of large aquatic lizards, and it is not necessary to describe the marks by which they are distinguished. The word "crocodile" will, therefore, be understood to signify the various species of Crocodiles and Alligators, the structures which enable them to trespass upon the water being practically the same in all the members of both groups.

Beginning with the first necessity of life—*i.e.*, respiration—we shall find in these huge lizards a most wonderful provision, which enables the animal to respire under disadvantageous conditions.

In the first place, the peculiar cellular structure of the lungs in all lizards assures a slow aëration of the blood, so as to suit the sluggish and cold-blooded circulation of these creatures.

A very little amount of respiration is therefore needed in these creatures, which are able to pass a considerable time without any respiration at all. This may be easily tested by watching the specimens at the Zoological Gardens, which lie flat on the bottom of their tanks for a very long period, looking as lifeless as if they were sham Crocodiles made of cast iron, and apparently regardless of the fact that they are completely covered with water.

Something more is, however, needed. The Croco-

diles feed mostly on animals which they catch upon the banks of the river in which they live. It is evident, therefore, that they must not only be able to exist for some time without respiration, but also without food, inasmuch as the conditions of obtaining food are of necessity precarious, and the animal may have to pass weeks without obtaining food. When urged by hunger, it rouses itself from its usual inactive state, and displays much ingenuity in seizing prey.

Crocodiles have even been seen to catch the little birds as they drink from the stream. The birds perch on a branch that overhangs the stream, and assemble upon it in such numbers that the bough is weighed down to the surface of the water, so that they may drink. Seeing them, the Crocodile makes a rush and a snap at them, when they fly off in great alarm.

The reptile passes on, as if chagrined at having missed his prey, and swims out of sight. The birds now settle again, thinking that their enemy has disappeared. So he has, but he has only sunk himself quietly below the surface. He then swims under water until he has reached the spot where the birds are drinking in apparent security, rises suddenly with open mouth, and is tolerably sure to capture some of them before they can escape.

Such small game as birds, however, are not so much to the Crocodile's taste as the larger animals, which it usually captures by knocking them into the water with a blow of its powerful tail, and then holding them under water until they are drowned. Human beings, dogs, and even the large and powerful cattle, are in this way destroyed, and it is chiefly on account

CROCODILE, HIPPOPOTAMUS, AND WATER-HOG.

of this mode of feeding that the Crocodile is furnished with the curious apparatus which will be briefly described.

As to the smaller animals, it can kill them with the gripe of its powerful jaws, but a buffalo, or even a full-grown cow or horse, would not succumb to the mere bite, and its struggles would be so violent that the Crocodile would scarcely be able to secure it. Even if the reptile were to plunge beneath the water with its prey, with the intention of drowning it, the severe struggle would force the Crocodile itself to need breath as well as its victim.

Moreover, if it were to submerge itself with open mouth, the water would pour down its throat, and very soon incapacitate it for further action. Some plan must therefore be devised which will enable the animal to be submerged with open mouth, and yet will preserve it from the inconvenience of having water pouring down its throat into its stomach. This, indeed, is much more important than the mere question of respiration, for, supposing both animals to be submerged simultaneously, it is evident that the hot-blooded mammal must succumb before the cold-blooded reptile.

The means by which this end is attained is beautifully simple and efficacious.

At the back of the throat, and just before the opening of the gullet, a broad plate of gristly substance passes completely across. The plate starts from the bony process of the throat, called technically "os hyoides," and extends completely across the back of the throat. From the upper part of the palate there hangs a flap of a similar substance, which envelopes the

lower plate, so that when the mouth is opened the pressure of the water forces one flap against the other, and effectually closes the aperture. And, as is invariably the case with such valves, the resistance is increased in exact proportion to the pressure, so that the deeper the Crocodile dives, and the greater the pressure of the water trying to force its way down the throat, the more firmly are the two parts of the valves squeezed against each other.

The valves of the heart, of the veins, and that which has been described on page 31 as aiding the respiration of the whale tribe, are all constructed on the same principle. At present, with all our advances in science, and having the advantage of such models, we cannot make such simple and yet such perfect valves as those which have existed ever since the reptiles took their place on earth.

Another point in the respiration of these creatures is yet to be mentioned. It may be that the animal is forced to respire, and yet cannot come into the open air. As in the case of many animals which pass much of their time in the water, the nostrils are placed at the extremity of the muzzle, so that the creature can keep itself entirely below the surface of the water, with the exception of an inch or two of nostril. The exposed portion is so small, that even in the open water it is not easily detected, while it can be entirely concealed by choosing some situation where there are reeds, or other aquatic vegetation.

The mode of progress through the water is exactly the same as that which is adopted by the fishes—namely, sweeping the body from side to side. In these

animals, the body is lengthened into a very long and very powerful tail, which, as we have already seen, not only acts the part of a propeller, but as a weapon. If a Crocodile be driven to fight, its tail is far more to be dreaded than its jaws, formidable though they may be, for its sweep is enormous, and the power of such a weighty mass, lashing about as sharply as if it were nothing but a slight whip, is sufficient to clear the ground of any foe which it may encounter.

The teeth, again, are adapted to the peculiar mode in which the Crocodile has to kill its prey. They are not intended for mastication, but simply for retaining the prey when it is alive, and tearing it when it is dead. In fact, they are of the kind that is popularly and graphically called "snatch-and-swallow." They are all conical, rather long, and sharply pointed, and are slightly curved, the curve being in the direction of the back of the mouth, so as to give a better hold on the prey.

As the struggles of some of the larger animals would probably break off one or two teeth before it was rendered helpless, there is a provision for their renewal. They are hollow, and filled with a pulp which is perpetually engaged in forming a new tooth within the old one, ready to take its place when it shall fall. I have in my collection an Indian shikarry's necklace, composed of fangs and claws of the tiger, claws of the great sloth-bear, and teeth of the Crocodile, all trophies of the owner's prowess in hunting. One of the teeth must have belonged to a very large Crocodile, as it is blunted and chipped from hard usage, while others are quite smooth and sharp.

The contrast between the tooth of the Crocodile and that of the tiger is very curious. In point of dimensions they are about the same, but in their shape and weight are very different: the tiger's tooth being solid, heavy, and flattened, with a distinct knife-like edge on the inner curve, while the Crocodile's tooth is hollow, light, and rounded.

These teeth are set in hollows in the jaw, and not consolidated with the bones of the skull. Consequently, they are easily removed, and, indeed, in dried skulls the teeth are always liable to fall out, owing to the shrinking of the soft material of the socket. It is evident, therefore, that the number of teeth must be extremely variable. In my collection there is a skull of the great Gangetic Crocodile, or Gavial, a huge reptile which sometimes attains the length of twenty-five feet. It has a very long and narrow head. My specimen belonged to a young animal, and the skull measures only twenty-six inches in length; yet, in the middle, the diameter of the skull is only one inch and three-quarters. Many of the teeth have fallen from the sockets, but some still remain, so that their size and shape can be understood. In the lower jaw there are twenty-five teeth on each side, and in the upper jaw twenty-nine, making a complement of one hundred and eight.

A figure of the African Crocodile is given in the upper portion of Plate II.

Another curious group of water-trespassers is to be found in the marine and aquatic members of the Tortoise tribe, some of which are vegetarians and others carnivorous.

Of the terrestrial species, the common Greek Tortoise is a sufficiently familiar example, being often kept in the garden. It is as well, by the way, not to allow it to visit the strawberry beds, as it will assuredly help itself to the fruit as soon as it ripens, and, stupid as it may seem, has quite sense enough to pick out the best berries. I had one for some five or six years, and was obliged, during the strawberry season, to keep it tethered on the grass by means of a string, one end of which passed through a hole bored in the shell, and the other was fastened to a weight too heavy for the creature to move.

In the marine turtles, the fore limbs, and especially the feet, are greatly lengthened and flattened, so as to form instruments of propulsion. The hind feet are also very wide and flat, but are not so much elongated in proportion as are the fore limbs. In the Hawksbill Turtle, which furnishes the "tortoise-shell" of commerce, the fore limbs are enormously elongated. I have in my collection a young Hawksbill that was captured almost immediately after it was hatched, and before the projecting shelly plates had been developed. In this little creature the fore limbs are so long that if they were straightened, instead of being bent, as they always are, they would be nearly as long as the entire body.

With these modified limbs they can propel themselves at a wonderful pace, and, if struck with a harpoon, will sometimes tow a boat for a considerable distance, and with a speed that is truly surprising. They do not seem, however, to be capable of long-continued exertion, and in shallow waters are some-

times taken by a couple of men in a boat, who chase the creature from spot to spot, and do not allow it to rest for a single moment. When it is quite tired out they strike the harpoon into it, and make it a comparatively easy prey. Even under these circumstances, however, the turtle always dashes off at a great pace as soon as it feels the point of the harpoon, and, were not the weapon constructed so that the point becomes detached from the shaft, the violent movements of the reptile would soon dislodge the harpoon, and, in all probability, break the shaft to pieces. As it is, however, the shaft is shaken off, floats to the surface, and is recovered, while the turtle is held by a strong line that is attached to the iron point, which is buried deeply in the reptile's back.

So effective is the swimming apparatus, that some of these creatures seem as much at home in the sea as do the whale tribe, and may be found hundreds of miles from land. A Loggerhead Turtle, for example, was once captured midway between the Bahamas and the Azores.

The distance to which the creature can swim is the more remarkable when we remember that although the turtles pass nearly the whole of their lives in the sea, they are forced to come to shore for the purpose of depositing their eggs. This they all do in a very similar manner. They select a sunny spot, some thirty or forty yards above high-water mark, and scrape a large hole by pushing their flat hind legs under the sand, and jerking it away, just as a child throws about the sand with its wooden spade. When the female has made an excavation some two feet deep, she

deposits in it about a hundred and fifty or two hundred eggs, scrapes the sand back again, and goes off to the sea.

Here, then, we have a case where the machinery which enables the creature to swim in the sea, also enables it to make short journeys on land, and to provide for its future young. The animal is a trespasser upon the domain of water, and not a denizen of it.

It has already been mentioned that some of these reptiles are vegetable feeders, while others are carnivorous. Yet, there is very little difference in the structure of their mouths; and for the following reason. Whether it eat animal or vegetable substances, it does not masticate its food, but only bites or tears it into pieces, small enough for it to swallow.

Both jaws are edged with a very strong, horny plate, nearly as sharp as a knife, and more or less waved, so as to produce a "drawing-cut," as swordsmen say, when the jaws are closed. Some of these creatures are much dreaded for their power of jaw; for they have been known to take off a man's finger at a single bite, or to sever in the same way an ordinary walking-stick. The lower jaw is rather smaller than the upper, and when the mouth is closed, the sharp edges of the upper jaw overlap those of the lower, so that they act just like a pair of shears.

Armed with these powerful instruments, the turtles can either crop the marine vegetation on which they feed, or even tear to pieces animal substances. Some species, such as the Loggerhead Turtle, which has just been mentioned, live almost entirely upon molluscs, their shear-like jaws crushing shells of considerable size and great hardness.

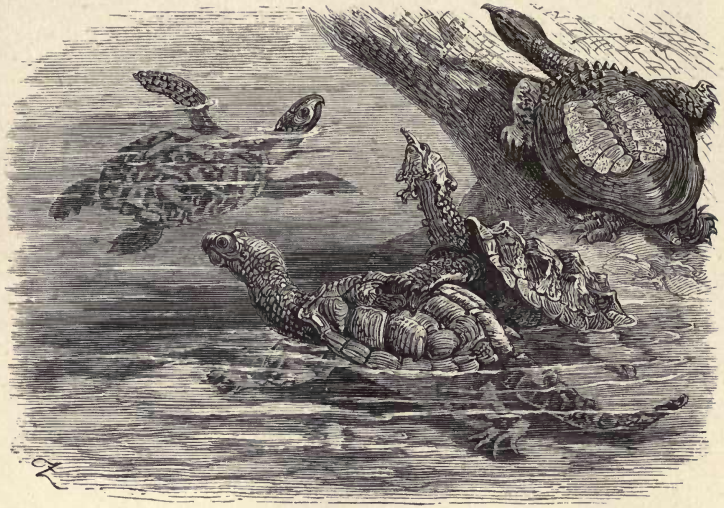
There are many species of turtle, of which the Green Turtle and the Hawksbill Turtle are the best known, and the most useful to man. The former is the reptile which is so justly famous as a delicacy, whether in the form of soup or cutlets. It is one of the vegetable feeders.

It has been noticed that most of the turtles which are brought to this country are females. The reason is evident.

Although they can be chased and harpooned in the manner that has been already described, such captures are rather matters of sport than of business. Those, therefore, who hunt the turtle by way of business, choose the time when the reptiles are obliged to come on shore to lay their eggs. They watch until she has finished the operation; and then, intercepting her as she is making her way to the sea, turn her on her back, and leave her. She cannot stir in this position, and the men are set free to attack another. The spots where the eggs have been laid are carefully noted, as the eggs, when preserved, furnish an abundant supply of excellent oil.

As to the males, they seldom trouble themselves to come to shore, and so it is that nearly all the turtles brought to England are of the female sex.

The Hawksbill Turtle, which is seen in the upper right-hand corner of the illustration on Cut 5 possesses a very singular development of the shell. As the reader may probably know, the shell of the Turtle and Tortoise is formed of a development of the vertebræ and the ribs, covered with a coating, more or less thick, of a horny substance. In the Green Turtle,



CUT 5.—HAWKBILL TURTLE, SNAPPING TURTLE, CHELODYNE, AND ALLIGATOR TERRAPIN.

this heavy coating is spread evenly over the surface of the bones; but in the Hawksbill Turtle, it is modified into a series of separate plates, which overlap each other like the tiles of a house, or the surface of an imbricated bud. They are rather leaf-shaped, the pointed end projecting, and the blunter end fixed to the skeleton. Altogether there are thirteen of these plates in every Hawksbill Turtle, the complete set being technically called a "head." One of these plates, which is in my collection, is exactly a foot long, by six inches and a half at its widest part. On it are six circular scars, showing the places where sessile barnacles have at one time established themselves.

On turning it over, and looking at the edges, it is easy to see how the plates are increased by successive depositing of new substance around the edges, the series of deposits being as clearly marked as the rings in the wood of an exogenous tree.

The whole of the upper surface is covered with multitudinous scratches in all directions, showing the rough usage which it must have endured during the life of the animal, and when merely viewed from the side it looks a very uninteresting object. A piece of black horn or pasteboard would be about as handsome. But, when it is held up to a good light, it is instantaneously metamorphosed, and becomes endowed with the richest mottlings of red, brown, black, and yellow.

It is rather a remarkable fact that the horny covering is removable from the skeleton by means of heat. The turtle hunters, therefore, who have not the least

idea that they are inflicting pain on a fellow-creature, do not kill the Hawksbill Turtles, but expose them to a steady heat, sometimes by the simple process of lighting a fire on their backs. The tortoiseshell being thus removed, the suffering creature is returned to the sea, where it grows a fresh set of plates, though they are not as good in quality as the original set.

We now pass to an allied group of water trespassers, popularly called by the collective name of Terrapins. They vary much in size, some, such as the Alligator Terrapin, being a full yard in length, while others, like the well-known chicken-tortoise, are barely six inches in length, even when the head is protruded to its fullest extent. As these inhabitants of land divide their time tolerably equally between land and water, it is evident that their limbs must be suited to either element. This is done by the simple plan of narrowing and lengthening the toes of both pairs of feet, and connecting them with a membrane.

They are fairly active, both in and out of the water, and, unsuitable as their structure may seem for such a feat, can scramble to the top of a large stone, or even make their way up the branches of a partially submerged tree. If such a tree be cautiously approached, it presents an extraordinary sight, being literally covered with tortoises, packed together like herrings in a barrel, or figs in a box, and having apparently about as much life in them. But, if a stick be incautiously snapped, or a hasty movement made, the whole assemblage drop into the water, and in a few seconds not a tortoise is to be seen.

I kept a couple of chicken-tortoises for some time, and very troublesome pets they were. Scarcely any precautions could keep them from escaping from their house, and whenever they escaped they always climbed up something. They were always pleased when set upon some elevation—say, a table, a shelf, or a chest of drawers. But the worst part of their conduct was, that whenever they were pleased to take fright, which was very often indeed, and without the least imaginable reason, they would scuttle off with such rapidity that it was almost impossible to anticipate them, and fling themselves down as fearlessly as if they had deep water beneath them instead of a hard floor. It was a curious example of the failure of instinct when ordinary conditions are altered.

They soon became very tame, and would come to me if food were offered to them. They swam with much celerity, and, in order to indulge their climbing propensities, I put some stones and set a brick on end in the middle of the vessel in which they were kept. Generally, they contented themselves with clambering up the stones and brick, but they always had a hankering for escape, and, if they could contrive to hitch one single claw over the top of the vessel, out they went, and often caused no small trouble in finding them.

Their mode of eating was remarkable. If a piece of meat were offered them, they would seize it in their jaws, close the mouth firmly, so that the sharp, horny edges should cut deeply into it, and then, placing one of the fore feet at either side of the mouth, they would push the meat forcibly from them, so as to

tear away the piece which was grasped in their jaws. They would repeat the process until the whole of the meat was swallowed.

One of them was a special favourite of mine, and when it died I preserved it after the manner taught me by the late Charles Waterton, and the *effigies* of the little creature is on my book as I write, in the exact attitude which it assumed when it expected food from me. It used to stretch its neck to the fullest extent, and rather on one side, with a curiously pleading expression in a creature which looks almost passionless. The beautiful colouring of bright yellow streaks on dark brown that adorned its head, neck, and limbs, has almost totally vanished, but the attitude is exactly the same as that which it so often assumed during life, and which, unless damaged by very rough usage, it will retain for years after the hand that preserved it has passed from off the earth.

I am told that some of the larger species of the same genus, *Emys*, attack fish, by coming quietly beneath them as they are sleeping, and then taking a bite out of the lower part of the body. I can well believe this to be the case, having personally known instances where even the little chicken-tortoise has killed numbers of gold-fish in this very way.

Two species of Terrapin are shown in Cut 5.

Occupying the lower part of the illustration is the great Alligator Terrapin (*Chelydra Serpentina*), to which allusion has already been made. The name Chelydra, by the way, is composed of two Greek words, and signifies water-tortoise. The name Serpentina, or snake-

like, is applied to the reptile on account of its long, snake-like neck.

As may be seen by reference to the illustration, the shell does not entirely envelope the body, as is the case with most of the tortoises, but merely forms a shield on the back, the whole of the legs being visible outside it, and the neck not able to be concealed within it, as is the case with the terrestrial tortoises. The animal is a tolerably good walker, and travels farther from the water than is generally usual among the aquatic tortoises. Still, it is not as much at home on land as in the water, and its gait ashore is as awkward and ungainly, compared with its easy gliding through the water, as the almost ludicrous waddle of a swan on land, compared with its proverbially graceful movements afloat.

It is one of the predacious tortoises, making much havoc among fish of various kinds, and especially delighting in eels, which it can capture in spite of their agile nature and slippery bodies, by the grasp of its strong jaws, which very much resemble the beak of a falcon. Indeed, should the struggles of the fish be very violent, the Alligator Terrapin would not have very much difficulty in shearing it asunder with a single bite.

It is easily kept in captivity, feeding readily on all kinds of butcher's offal, and, as it seems to be always hungry, it is often captured with the hook. Terrapin fishing is thought to afford very good sport. The line is a very strong one, and for a few yards from the hook is covered with wire, like the "gimp" used in pike fishing. For not only would the sharp jaws shear

asunder any ordinary line, but the creature has a way of bringing its fore feet to bear upon it, and snapping it by main force, which, as it sometimes reaches three feet in length, it is certain to do with any ordinary line.

Like most of its kind, the Alligator Terrapin is valued for the table, and is kept alive to be sold in the market. The popular name of alligator is given to it because in America all the crocodiles are called alligators, and the reptile certainly does look very much like a small crocodile with the shell of a tortoise upon its back.

Nearly in the middle of the illustration, and just above the Alligator Terrapin, is shown the Australian river tortoise, called the Chelodine. There are many chelodines, but this has been selected as an example of an Australian water trespasser, belonging to the great group of tortoises. Its scientific name is *Chelodina longicollis*. The latter of these names signifies "long-necked," and is given to the animal because its neck is very long, thin, and flexible. For the same reason, the popular name of snake tortoise has sometimes been given to it.

It is also called the yellow chelodine, in consequence of the colour of the horny plates or shields, which are yellow in the centre and black on the edges. It is rather remarkable, by the way, that although the shields of the hawksbill turtle retain their richness of colour as long as the material itself exists, the shields of many other chelodines becomes dull and dark soon after death.

This contrast is well shown in the shield of the

hawksbill turtle and the preserved chicken-tortoise, which have already been mentioned. The former retains all its rich mottlings, although many years have elapsed since I took it from a barrel at the Docks. The latter has entirely lost its colouring. When the little creature was alive the shields were olive-brown, with a net-like pattern of a paler hue, and in the middle of each was a pale ring edged with black, from which diverged a number of lines towards the edges of the shield. Now all this colouring has faded, and the colour is dull, brown-black, with a few blacker lines on each shield.

It is easy to understand that the yellow stripes upon the skin should fade away after death, but that the colour of the horny plates should alter is as unexpected a fact as if black or brown human hair were to turn white after it had been severed from the head.

The Australian chelodine loves stagnant water in preference to running streams, and feeds upon the slow-paced fishes, the frogs, and similar creatures which inhabit the same localities.

The last of the tortoise water trespassers which can be described in these pages is the Snapping Turtle, as it is popularly called, its scientific name being *Trionyx ferox*. The name is probably familiar to my readers through the medium of the "Bon Gaultier" legends, where "Slingsby, of the manly chest," defied and slew the "snapping turtle of the West."

I very much regret that the clever illustrator of this work did not draw the real snapping turtle instead of a mere green turtle, which is a very harmless being. He would have made a much more effective picture.

The real snapping turtle has a very ferocious look about it, while the green turtle is one of the mildest and foolishest-looking of reptiles. The name trionyx is Greek, and signifies three-clawed, in allusion to the structure of the feet, only three toes of each foot possessing claws, although the full complement of five toes is possessed by the reptile.

It well deserves its name of snapping turtle, for it snaps and bites with astonishing ferocity; while its long and lithe neck enables it to bring a considerable area within reach of its jaws. It feeds mostly on fish, but catches various water-fowl, and is not above eating young alligators when it can find them.

Its voracity renders it liable to be taken with a hook and line, as has been related of the Alligator Terrapin; but it requires very strong tackle, and a skilful hand, to land it safely. It is so heavy, so strong, and so active, that an angler who caught one of these creatures when he was expecting a fish, compared it to a mill-stone with a steam engine inside it. Fish is perhaps the best bait for this reptile. After it has been captured, it is generally placed in a tank and kept alive until wanted; the injury inflicted by the hook not affecting it in the least.

So indifferent is the creature to injury, that after the head has been severed from the body, the former will snap and bite for a considerable time, as if it were possessed of its body; while the latter will crawl about as if it were still possessed of its head. In one case, where a snapping turtle was decapitated, and then plunged into boiling water, the heart was still pulsating; and, when removed from the body and

placed on a table, continued to beat for some twenty-four hours longer.

Like the Alligator Terrapin, the snapping turtle is highly valued as an article of food, and is kept for this purpose just as we keep the green turtle in the tanks called "crawls." In England, the turtles spend one day in the tank, and the next on the floor of the cell; this plan being found to keep them in good health.

There is an African representative of the snapping turtle, called the Tyrse (*Trionyx Nileticus*). As its specific name implies, it inhabits the Nile, and there makes much havoc among the young crocodiles. Both these creatures belong to a small group of aquatic tortoises, called soft turtles, because the hard shell-covering only extends over a part of the back, leaving the rest comparatively soft. They owe the name of turtle to their size, although, as is shown by the structure of the feet, they are only tortoises who are qualified by their webbed feet for swimming in the water.

We now come to another group of reptilian water trespassers. We have seen how the lizards are thus represented by the crocodiles and alligators; the batrachians by the newts, frogs, and toads, and their kin; and the tortoises by the turtles of the ocean, and the various aquatic tortoises of the rivers and lakes. Only one group of reptiles now remains, namely, the Serpents; and even among them we find many species that are as much water trespassers as are the newt or the turtle. All snakes, I believe, are able to swim;

and, to judge by our common Grass Snake or Viper, they undulate their way through the water in a most graceful manner. Then there are some, such as the Black Snake of Australia, which is often called the Water Viper, from its habit of frequenting the rivers.

But there are some species of snakes which live almost entirely in the water; and, like the whale or the dolphin, soon die upon dry land. They all inhabit the same latitude, and are common in the Indian seas, where they always excite the admiration of those who see them for the first time. Mr. Williams, the well-known missionary, in his "Narrative," mentions the water snakes which he saw, some striped with yellow and black, and others ringed with white upon a black ground. Both kinds are considered to be valuable articles of food, as are those species which live on the shore.

I possess a copy of Bennett's "Whaling Voyage," which has evidently passed through the hands of an old whaling captain, who has annotated it profusely. His experience is evidently very wide, and his remarks are valuable; but his literary education has been much neglected, and the mode in which he conveys his information is often most ludicrous. He has a strong objection to the "Mishunnarys," as he is pleased to call them, and invariably prefaces the word with some powerfully depreciating epithet. Every evil is laid on the shoulders of the missionaries. For example, there is an account of a certain disastrous war, which is annotated as follows: "There is not one wourd of truth in this steatment; Mr. Willims, Since killed in Dillons Bay Erremanga, caus this bluddy war."

In vol. i., p. 67, Mr. Bennett remarks that no Serpents are found on the Society Islands, though water snakes are not uncommonly seen on their coasts. On the margin of the page, there is an annotation as follows: "There was no such Sneaks in my time."

With all his prejudices against the "Rascelly Iggerent Mishunnarys," with whose misdeeds the book is plentifully sprinkled, his notes are really valuable when he comes to his own practical experience; and among them are many upon subjects of natural history, which have the advantage of being written by a man who merely relates his own observations, without having any theory to carry out.

For example, in vol. ii., p. 74, Mr. Bennett makes the following remarks on a species of water snake: "While we were yet engaged in the strait, my townet captured a Water Snake (*Hydrophis bicolor*). It was two feet in length; the upper surface of the body uniformly black; the inferior of a bright-yellow colour; the tail vandyked with black and white. It had the ordinary form of a land snake, with the exception that the belly was keel-shaped, and the tail compressed (to facilitate swimming), and blunt at the extremity. The teeth were similar to those of innocuous land snakes.

"It should be remembered that some sea snakes have tubular, or poisonous, teeth mingled with the true teeth.

"It did not appear much inconvenienced by being removed from its natural element; and when taken on board the ship, resembled the terrestrial snakes in its

mode of rearing the head, gazing fixedly, and rapidly protruding and retracting a cloven tongue. It did not appear, however, to possess any power of progressing on land; since, when placed on the deck of the ship, it made the lateral motions usual with land snakes, but could not advance. It uttered no sound, nor did it make any attempt to bite. On dissection after death, I found several small fish in its stomach."

This passage is annotated as follows :—

"Thees Sneaks are Numerous at the fegee Isslanes, and bask in the Sun on the Rocks, the breed on Shore."

This species is a very pretty one, being black above, and light yellow beneath and on the sides, whence it derives its name of "bicolor," or two-coloured. It scarcely ever comes on shore, except for the purpose of depositing its eggs, which it lays tolerably near high-water mark, so that when the young are hatched by the heat of the sun, they can make their way into the sea with very little trouble. It is, on the average, about three feet in length.

Before examining the different species of water snakes, we will glance at a few details of structure. The first point is, as has already been noticed in all water trespassers, the power of respiration.

In the Serpent tribe, there is no necessity for special structures for the use of the water snakes. The lungs are most curiously formed. They are long, nearly cylindrical sacs, looking, when inflated, very much as if they were meant to receive sausage-meat. If carefully injected, it is seen that only the upper part is vascular; so that nearly the whole of the lung

is nothing more than a receptacle for air, the reptile having therefore always within it a supply of air that will aërate the blood for a long time.

Many years ago, when I had a school, my boys were accustomed to make pets of snakes, and to carry them about in their pockets. One of their amusements was, to take their pets to a deserted stone quarry, which had become half-filled with water, and give them a swim. They used to have races across the quarry; and, as a rule, the snakes went straight across. Sometimes, however, they would dive, flatten themselves against the bottom of the quarry, and there remain until they were roused by a stone dropped over them. The time during which they would remain submerged was astonishing; and not even a frog could hold out longer, if so long.

Now, in the marine snakes, which spend almost the whole of their time in the water, the lungs are very large indeed; so that the reptile can lie quietly sleeping on the surface of the water, being kept afloat by the large and inflated lungs. If the snake can be detected in this position, it can be easily taken, as it must partially empty the lungs before it can dive; and this is a work of some little time, the reptile being obliged to throw itself on its back. I imagine that the specimen which was caught in Mr. Bennett's net, must have been taken while it was thus lying asleep.

Another point connected with respiration is, that in the water snakes, the nostrils are furnished with a structure which fulfils the same purpose as the corresponding portion of the whales and dolphins. They are fitted with a sort of valve, which effectually closes

them while the reptile is beneath the water, but can be opened for the purpose of respiration when at the surface.

The second point in the economy of a water trespasser, is the manner of progression. It has already been mentioned that all snakes can propel themselves through the water by an undulating movement of the body. Those species, however, which almost exclusively inhabit the water, have their structure modified so as to suit their way of life. The tail portion of the body, instead of being round, like that of the land snake, is widened and flattened; assuming, in fact, almost the exact shape of the eel's tail.

There are many species of water snakes, more than seventy species being in the collection of the British Museum. Some of them, among which is the species which has just been mentioned, are such thorough trespassers on the sea that not only cannot they live upon land, but they soon perish in fresh water. Occasionally, when there has been a severe storm, they are thrown ashore, where they very soon die. Sometimes they are driven up the mouth of tidal rivers, but, unless they can make their way to the sea, they do not long survive the change of element.

They are among the venomous Serpents, and are held in great dread by the fishermen, in whose nets they are often accidentally taken.

As is the case with many fishes of the warmer seas, the colours of these water snakes, though brilliant during life, are fugitive after death, and often vanish entirely from the stuffed skin. It is a curious fact that even during life the colours are brightest in the young

specimens, and so dull in the old that they are nearly entirely of one colour. For example, in the present species, which is called the Black-backed Pelamis, the young snake is yellow below and black above, while the old snake is almost entirely black.

This species has a very wide range, the specimens in the British Museum having been taken off the shores of India, Borneo, and New Zealand; and there is one specimen which is believed to have been captured near Madagascar. It is common enough in India to have received a vernacular name, and is called by the natives Nalla Whallagee Pam.

Then there is a genus of Asiatic marine snakes, which are called by the common titles of Shooter-sun and Chittul by the natives, and are known to zoologists by the generic name of Hydrophis.

About fifteen species of Hydrophis are in the British Museum; but there is the greatest difficulty in determining a species of Hydrophis, the marks which are generally used for this purpose being exceedingly variable, not only in different species or in different individuals of the same species, but in the same individual.

For example, the shield-scales of the various parts of the head are used as means by which the species can be determined. In the Black-backed Pelamis the specific distinction lies in the number and arrangement of the scales about the eyes; but in some specimens the scales on the one side will be quite different from those on the other, so that it is very possible that mere varieties may be counted as species, or species as varieties. In the British Museum there

are very many specimens of the Black-backed Pelamis, and, in order to attain some kind of arrangement, they are divided into six different groups, each of which is so distinct from the others that it is not easy to decide whether they may not be totally distinct species, instead of simple varieties of a single species.

They have very long, slender necks, and sometimes attain the length of four feet.

The species which is represented in the illustration is the Banded Chersydrus (*Chersydrus granulatus*), so called because its body is marked with bands of white on a black ground. There are also white spots upon the sides, the tail, and the head.

It inhabits the shores of India and Java, and by the natives of the latter country is called Oular-limpè. It is not such a sea-going reptile as those which have just been mentioned, preferring inland bays and the estuaries of large rivers, where the water is brackish rather than wholly salt. When the water is clear these snakes may be seen lying on the bottom.

From this attachment to the land as well as the water, it has received the name of Chersydrus. This title, as Greek scholars will know, is composed of two words, the former signifying dry land, and the latter signifying water. All these water snakes, indeed, have received names expressive of their habit, structure, or colour. For example, taking the Nalla Whallagee Pam. Its generic name, Pelamis, is formed from a Greek word signifying the sea; and its specific name, bicolor, or two-coloured, refers to the black and yellow of its hues. The name Hydrophis, again, is formed from two Greek words, signifying water serpent.

Beside these flat-tailed, eel-like water snakes, there are many others which are frequenters of the water, but prefer fresh water to salt, and cannot trust themselves so far from land as do the true sea-snakes.

Several of these are placed in the genus Cerberus, and are probably so called on account of the almost repulsive ugliness of their large heads. They are not dreaded as are those which belong to the group which has already been described.

The commonest of these snakes is the Karoo Bokadam of India, Borneo, etc. It is a brown snake, banded with black across the back, having white sides and a black belly, mottled with black. The tail is black, and there are a few pale spots along the sides.

CHAPTER VI.

Partial Water Trespassers.

CARNIVORA.

We will next take another series of mammalia, which may be called Partial Trespassers in the water, and shall find representatives of them among the carnivora, the rodents, the pachydermata, the marsupials, and the monotremes. We will begin with the Carnivora.

Perhaps the best-known examples of these animals are the various species of Otter, most of which frequent rivers and lakes, though some prefer the sea.

In these aquatic weasels, for such are the Otters, we cannot but admire the mode in which the form is modified so as to suit the element in which they have to obtain their food. Both the terrestrial and aquatic weasels have to capture prey by chase, and as the prey of the Otter is exclusively found among the fishes, it is evident that the structure of the body must be greatly different in the two groups.

The first point which strikes the eye of an anatomist is the use which is made of the tail. In the terrestrial weasels, such as the common weasel, the stoat, the badger, the ratels, etc., the tail is very short and insig-

nificant. Considering their habits, these animals would only be incommoded by a long tail, and it is, therefore, abbreviated to suit the conditions of their life. But when the animal has to propel itself rapidly through the water, and to be endued with great agility as well as speed, it is evident that as it is a trespasser in the domains of the fishes, it must have something of the fish-structure.

This object is attained chiefly by the form of the tail, which, instead of being short and insignificant, as in the terrestrial weasels, is very long, thick, and powerful. Moreover, it is slightly compressed. By means of this organ the Otter can propel itself through the water with wonderful rapidity, the movement being from side to side, just as is the case with the whales, the seals, the crocodiles, the newts, and the water-snakes.

Besides the tail, the Otter has other instruments of propulsion—namely, the feet, the toes of which are webbed, so as to present a wider surface to the water. The feet, however, are more used to balance and direct the body than to propel it, as can easily be seen by watching the animal as it pursues its course through the water.

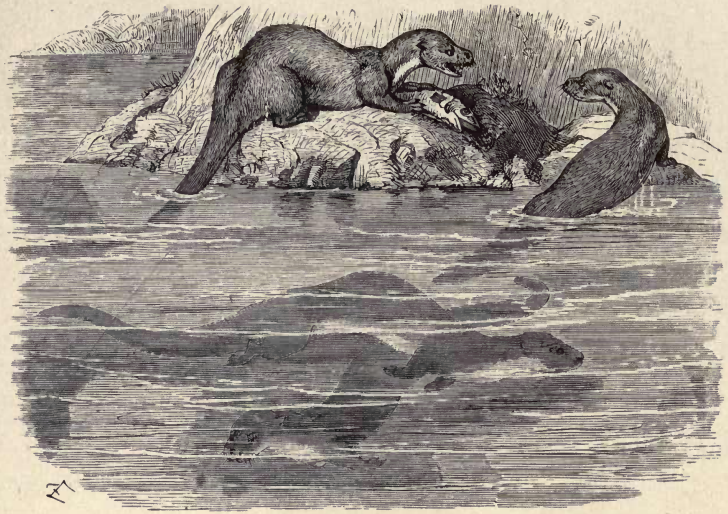
It is absolutely impossible to exaggerate, and not easy to describe adequately, the wonderful beauty, ease, and gracefulness of its movements in the water. On land, though it can proceed at a considerable pace, it has anything but a graceful gait. Its ordinary walk is a pattering trot, but when it is hurried it changes its pace to that of an up-and-down kind of gallop, which certainly is speedy, but is not graceful. This peculiar

gait is caused by the length of the body, the shortness of the legs, and the distance between the fore and hind legs. As the creature goes galloping along, the back is arched at every leap, and the entomological spectator is at once reminded of the peculiar mode of progression adopted by the looper caterpillar.

The animal is perfectly aware of its inferiority on land, and seldom trusts itself far from water. Almost the only exception is when the rivers are so frozen that it cannot obtain its ordinary food, and is obliged to hunt for game on land, like its terrestrial relatives. Under such conditions it has been known to enter farm-yards at many miles' distance from the river which it frequents, and to make as much havoc among the poultry as would be caused by a marten or a polecat.

If, therefore, it be alarmed when on land, it always makes for the water at once, dives, and can swim to a considerable distance before it emerges. Its mode of respiration is rather peculiar. The lungs are capacious, so as to contain a large quantity of air, and as the animal swims below the surface it continually expires the air which it had taken into its lungs, so that as it goes along its progress can be traced by the rising air-bubbles. The supply of air being exhausted, it rises to the surface, takes a breath, and again dives. The rapidity with which this operation is conducted seems rather startling until we recollect that as the animal has already emptied its lungs under water, it only needs to make a single inspiration to complete the act of breathing.

When the Otter goes into the water from the land, it slips in as noiselessly as if the water were oil, and,



CUT 8.—OTTERS.

with easy wavings of its tail and undulations of its body, glides along with admirable ease and elegance. It is seen to great advantage when at play with a companion; and as there are mostly some living Otters in any Zoological Gardens, there are plenty of opportunities of seeing them. It is in these mock encounters that the use of the webbed feet is best seen. As they twist, and turn, and double beneath the water, the feet, and especially the fore feet, are used for this purpose, just as a swimmer alters his course by means of his hands. The tail is all the while used for propulsion, and partly for direction, but the doubling below the water is achieved almost wholly by means of the feet.

There are few more interesting sights than to watch Otters at play with each other. The infinite variety of graceful attitudes as they twine and undulate beneath the surface must be seen to be appreciated. They pretend to fight, just like a couple of puppies at play, grasp each other with feet as well as with teeth, roll over and over, and then, with a single wave of the tail, they shoot out of the water upon the bank, gallop round and round, and then glide again into the water to pursue their graceful sport.

The shape of the head calls for some attention. It is broader and flatter than in the terrestrial weasels and has the nostrils placed high as well as the eyes, so that it can both breathe and see without exposing more than a few inches of surface. The same modification of structure is to be seen in the hippopotamus and crocodile, both of which creatures, in spite of their enormous size, expose so small a surface to the open air, that even a good rifleman has to take his most

careful aim before he can plant his bullet successfully.

In order that the Otter should be enabled to retain the slippery and active prey on which it feeds, its canine teeth must of necessity be long and sharp, and its jaws powerful. But many Otters live habitually on the salmon, one of the most powerful and active fish of our rivers. In course of time they become epicures, only kill the finest fish, and are dainty enough to eat only the shoulders, leaving the rest on the bank.

Many a shepherd has kept himself well fed by discovering the larder of one of these old Otters, and taking the fish which the dainty creature had left on the bank. Perhaps scarcely half a pound of the fish would have been eaten by the Otter, the remainder falling to the man, who of course took very good care not to reveal the dwelling-place of so useful an ally, and never to disturb the animal at its food.

Any one who has caught a salmon can appreciate its strength. Even when landed, it struggles so fiercely, that only experienced fishers can hold it, and its power in its own element is necessarily very much greater. Yet the Otter can swim faster than the salmon, turn more nimbly, and when it has once grasped its prey is strong enough to bring it to land. This fact shows that the neck must possess the double qualities of flexibility and strength, and accordingly, if the skin be removed, the neck is seen to be clothed with muscles quite as strong, in proportion to the size of the animal, as are those of the lion himself.

Indeed, there are few creatures in which flexibility and power are so wonderfully combined as in the Otter.

As it moves about in the water, it scarcely seems to possess any joints at all, so easy is the turn of the body and limbs. Yet when it sets itself to a struggle with its prey, its whole character seems to be changed, and the entire framework of the animal becomes as rigid as if the bones and sinews were of steel.

This can be readily seen by throwing a fish into the water at the Zoological Gardens. Of course, in such limited dimensions, there is little scope for flight on the part of the fish, or chase on the part of the Otter. But the Otter can "make-believe" as well as any child at its play, and it generally makes believe that the fish is a large salmon, which is costing a hard fight before it yields.

Then, after it has safely landed its prey, the Otter places its fore paws on the fish, seizes it in its mouth, and tears it to pieces with a crunching sound that speaks plainly of the great strength that is employed in the operation. It is no wonder that few dogs can be found to face the Otter in fair fight, and that even the best-trained Otter hounds have all their work to do in securing an animal which can twist about like a snake and bite like a badger.

It seems somewhat curious that while the falcon should have been trained to catch birds in the air, and ferrets to chase rats and rabbits beneath the ground, the Otter, which is a near relation of the ferret, should not have its aquatic powers utilized, and be taught to catch fish for its trainer, instead of depopulating the river on its own account and in its own wasteful manner.

It is trained in some parts of India and China, and

is kept near the water, tethered by rope and collar until wanted. This animal is the Chinese Otter, or Indian Otter (*Lutra Chinensis*), which is spread over a considerable portion of Asia. The reader may remember that the cormorant is used for a similar purpose; but as reference will be made to that bird in a future page, it needs at present only a passing mention.

The Otter would be even more valuable than the cormorant for this purpose, and for the following reason: The instinct of the cormorant teaches it, when it has caught a fish, to swallow it on the spot; but the instinct of the Otter teaches it, under similar circumstances, to bring the fish ashore. It does not swallow its prey whole, like the cormorant, but, as we have already seen, tears it to pieces with its teeth, while holding it down with its fore paws.

As the present work does not pretend to give a detailed description of all the water trespassers, but only to give a slight sketch of them and the modifications of structure which will enable them to trespass upon an alien element, I shall only mention one other species of Otter—namely, the Sea Otter (*Enhydra Lutris*).

This is a most singular animal, and presents a remarkable contrast to the structure of the Otters in general. As has already been mentioned, in the generality of the Otters, the tail plays the most conspicuous part. But in the Sea Otter it is quite short, and is, in fact, scarcely larger, in proportion to the size of the animal, than that of the stoat or common weasel. In order, however, to compensate for the smallness of the tail, the body is very much elongated, and the hind

legs are set on in such a way that they present a curious resemblance to the flippers of the seal.

Indeed, so strongly marked is the similitude, that several systematic zoologists have considered that the Otters form, through this species, a transitional link between the weasels and the seals.

Although it is popularly called the Sea Otter, it does not restrict itself to the sea, but passes a migratory existence. It inhabits the shores of the Northern Pacific, and as the winter cold of that locality is very severe, the rivers and lakes are frozen for a considerable portion of the year, so that no Otter could live if it were dependent on fresh water.

During the warmer seasons of the year, the Sea Otter inhabits the inland lakes, and feeds upon the fresh-water fish. When, however, the frosts of winter begin to approach, the Otter is led by instinct to leave the lakes and descend the rivers until it reaches the sea. Here it is sure of obtaining food, and here it remains until the summer's sun has broken up the ice of the fresh water, when it returns to its former locality. In default of fish, it can feed upon crustacea and molluscs, its powerful teeth enabling it to crush even the hard and strong shells with which the greater number of marine molluscs are protected.

As is the case with the seal, and particularly with those species that are confined to northern climates, the Sea Otter is furnished with very thick and warm fur. This fur is doubly valuable—firstly, because it is very soft in texture and rich in colour; and, secondly, because the animal is a rare one, and not easily captured when discovered.

The colour of the fur is a very deep black-brown above, and whitish beneath. The animals live in pairs, and are said to produce only one cub at a time. In size it is far superior to our British species, for whereas the common Otter weighs, on an average, about twenty-four pounds, the Sea Otter weighs from seventy to eighty pounds.

Unsuited as the Bears may seem for aquatic feats, they yet have a representative as a water trespasser—namely, the well-known Polar Bear, or White Bear, so called from the cream-white colour of its coat.

It is well known that in the colder regions there are many creatures which assume a white hue in the winter-time. The common ptarmigan of Scotland is a familiar example which occurs within our own island. Then there is the Arctic fox, which becomes perfectly white in winter, and the Arctic wolf, which becomes pale grey, while the lovely white ermine is, as most people know, merely the common stoat, which has assumed its winter clothing. The last-mentioned animal, by the way, has been artificially bleached by keeping it in a cold atmosphere; and even in our country are occasionally found stoats which have partially assumed the white winter's dress of the ermine.

In all those creatures, however, the white hue is but temporary, and at the beginning of the warm weather the ordinary dark hue of the fur or plumage is resumed. The white bear, however, forms an exception to the general rule, the fur retaining its white colour through life, and even keeping it when the animal is brought to a warmer climate. Several Polar

bears have lived for years in the Zoological Gardens, and in spite of the many hot summers which they have painfully endured, the fur has never darkened.

Various reasons have been adduced for this retention of the white hue. I think, however, that its condition as a water trespasser may afford a very sufficient reason. The animal feeds partly on fishes, but its chief food consists of seals. In fair chase, the bear would have but little chance of catching so speedy and active an animal as the seal, and it therefore employs stratagem to attain its object.

Seals always resort to the shore for repose, and have a very curious fashion of sleeping. They take short naps of barely ten seconds each, raising their heads and looking about them between each nap. The Polar Bear takes advantage of this peculiarity, and when he sees a seal asleep on the land or an ice-floe, he makes his approach with the greatest caution.

He first dives and swims under water in the direction of his intended prey, only just putting his nose above the surface for the purpose of breathing. When he has thus reached the shore, he scrambles upon it during one of the seal's naps, and lies motionless while it takes its customary survey. As soon as the seal lays down its head, the bear hitches himself towards it by means of his claws, and again becomes quiet as soon as it awakes. He then contrives to come near enough to cut off its retreat to the water, and is perfectly sure of his prey, the seal having no more chance against the bear ashore, than has the bear against the seal in the water. The seal can scuttle along at a tolerable rate, but the fur-soled feet of the bear gives the animal

so firm a hold of the slippery ground that there is no difficulty in intercepting and killing the seal.

The reader will now see why the colour of this water-loving bear should be white. If, during one of its brief intervals of wakefulness, the seal were to espy a dark object floating in the water, its suspicions would at once be excited, and it would make off to a place of safety before it could be captured. But, at a little distance, the white body of the Polar Bear looks just like a lump of floating ice, and the seal, therefore suffers it to approach, being in ignorance of its true character. It is in the approach by water that the bear's chief difficulty lies, for, as we have seen, if he can only manage to interpose between the seal and the water, the fate of the destined prey is assured, unless it happens to be near a hole in the ice.

It is rather a remarkable fact that the Esquimaux seal-hunters have borrowed from the Polar Bear two modes of catching the seal. One mode is by imitating the method of approach to the sleeping seal, the hunter lying flat on his face, and hitching himself along gradually during the short naps of the animal. So skilful are the men at this work that they will often contrive to kill the seal even though it should be close to a hole in the ice. The animal has mostly strength enough to plunge through the hole, but is retained by the rope attached to the harpoon.

The second mode is that of catching the young seal in the igloo, which has been described on page 64.

The bear manages to find out by its sense of smell the exact position of the igloo. It then goes to a little distance, leaps with all its weight on the igloo so as to

break in the roof, and seizes the young seal before it can escape. The hunter does just the same thing, except that he uses his dog's nose for the discovery, and his spear instead of claws.

The modifications of form which permit the Polar Bear to become a trespasser upon the water are few and simple, but effective for their purpose. As the animal is not intended to remain below the surface for any length of time, no change of structure is needed in the respiratory organs. As, however, it is obliged to be very active in the water, and to swim to long distances, the means of locomotion must evidently be very different from those of the terrestrial bears.

In the first place, the body is longer and more flexible, while the neck is so much elongated as to remind the observer of the same part of a weasel, and is almost as flexible as that of the otter, which has already been described. Then, the head is of a rather peculiar shape, tapering regularly from the forehead to the nose, instead of having a depression at the base of the snout, as is the case with land-inhabiting bears, this form being probably given in order to enable the animal to dart its head faster at its prey than it could do if it were broad and thick.

The chief instruments of locomotion are the feet, which serve to transport the animal over land or ice, or to propel it through the water. They are very much longer and broader than those of the terrestrial bears, measuring, in fact, one-sixth of the length of the body. By means of these four paddles, the bear, in spite of its large size, can play about in the water almost as actively as the otter itself, and is so swift and quick

that it has been seen to chase and capture a salmon in the open sea. So powerful is the action of its feet while swimming that, when it is much excited in chase of prey, it can make a succession of long springs out of the water, just as one may sometimes see a pike do when chasing a smaller fish.

Both the sole and the upper part of the foot are clothed with stout and long hairs. Those of the sole are invaluable in giving the creature a foothold upon the ice, and the latter act as a sort of pent-house to shoot the water away from the foot when the animal lands.

There is a peculiarity also about the fur, which, I believe, had not been publicly noticed until I called attention to it in an article published in the "Daily Telegraph." Ordinarily, the hairy clothing of the Polar Bear is as impervious to water as the fur of a seal or the feathers of a duck, and, when the animal comes on shore after a dive or a swim of thirty or forty miles, its skin is perfectly dry, though the water pours in torrents from its back. But, in order to perform this office properly, the skin must be perfectly clean; and this fact was discovered in rather a curious manner.

A young Polar Bear was added to the collection at the Zoological Gardens, and as soon as it was transferred to the den, it plunged joyfully into the water, and swam about for a little time. Presently, however, it was seen to be in difficulties. It sank lower and lower in the water, and became so weak by struggling that it was not able to drag itself ashore. Fortunately, the keeper was, as usual, on the alert, and, by letting off the water, contrived to save the creature's life.

It seems rather absurd that an animal which can chase and capture a salmon in its own element, and swim thirty miles, should be in danger of drowning in a little tank not so large as a moderate-sized room. The reason, however, was soon apparent. The animal had travelled for a considerable distance by land, without any opportunity of getting at water. Consequently, its fur became choked with dust and dirt, absorbed water like a sponge, and was very nearly the cause of its owner's death.

The water-resisting power of fur will be mentioned in the description of the animal next on our list.

Still taking the carnivorous animals in their zoological order, we find that the insect-eating carnivora have several representatives as water trespassers. We will begin with one little animal that is very common in this country, but not nearly so well known as might be imagined from its numbers. The fact is, it is a quick and very little creature, and the sound of a human voice or even a heavy step at some distance will send it to its secure hiding-place.

Everyone is familiar with the long-nosed Shrew-mice that are found lying dead about the roads in autumn, and used at one time to be objects of superstitious dread to the ignorant. Several members of its family are as much at home in the water as the polar bear, their best representative being the Water shrew (*Crossopus fodiens*), which is shown on Cut 7.

I am tolerably sure that these little animals exist on the banks of many streams where their presence is not even suspected. I have found them in places

where no one would think that the creatures could pick up a living, and have always been much interested in them. As far as I have seen, they do not appear to travel to any great distance from their burrow, so that although there may be several families of water shrews within a mile, every yard of the stream must be carefully inspected before they can be found.

In some respects, the modifications of structure which enable them to become water trespassers resemble those of the polar bear. As in that animal, the feet are the instruments of propulsion, are long and wide, the width being gained partly by the length of the toes, which can be spread well apart, and partly by the fringe of stiff hairs which surround them, and which acts just like the hairs in the rowing legs of the water-beetles.

The generic name of Crossopus, or tassel-footed, is given to the various Water shrews in consequence of this hairy fringe to the feet. When the creature is carefully inspected, it will be seen that from the manner in which these hairs are set upon the foot, they hold the water like the blade of an oar while the animal is making its stroke, and yield to the water as the limb is drawn forward in readiness for the next stroke.

We will now revert for a time to the question which was mentioned at the end of the account of the polar bear—namely, the capability of fur to resist water.

At first sight, it appears absurd to suppose that hairs, when laid side by side, can resist the action of water, and keep the animal perfectly dry though it may be submerged for a considerable time. Such an opinion

would be perfectly justified. Taken alone, no amount of hairs would keep water from the skin any more than water could be carried in a sieve. But another element has to be considered—namely, the air which entangled among the hairs, and which is the real barrier both to the penetration of water to the skin, and of loss of animal heat through the skin into the water.

Some of my readers may perhaps have tried to pour water into an empty vessel through a single narrow aperture, and, if they have done so, have signally failed, the air in the vessel not permitting the water to enter. Suppose, for example, that the vent-peg of an empty barrel be removed, and a funnel tightly inserted in its place. The funnel may be filled with water, but not a drop will enter the barrel, the invisible air within forming a barrier as effectual as a cork or a stopper.

There is an amusing little trick which is sometimes played upon unsuspecting persons, and which illustrates this property of air. An empty soda-water bottle is laid on its side, and a piece of cork about as large as a pea placed within the neck. Anyone is then challenged to blow the cork into the bottle. This looks so easy that a person who does not know the trick, or whose knowledge of the properties of matter does not enable him to see through the attempted delusion, advances and blows sharply into the bottle. To his great surprise he finds himself struck in the face with the piece of cork, which he has blown out of the bottle and not into it.

The fact is, the bottle, although it looks empty, is really full of air; and just in proportion as air is blown

into it, the air that already exists is blown out, carrying the cork with it. The only way to get the cork into the bottle is to coax it, so to speak, by blowing very gently and steadily on one side, so that the air within the bottle is allowed to escape gradually, and the cork slowly rolls along the side of the neck until it is fairly within the body of the bottle.

These two examples illustrate the action of fur upon the life of the animal, and show that the very same property which keeps an animal warm in winter, keeps it dry in water. In itself, fur has no warmth; and, if in the depth of winter, a thermometer were applied to a fur coat and a steel cuirass, each would be found to be of the same temperature; though the former would keep a man warm, and the latter freeze him to death. Air is a very bad conductor of heat; and, as there is much air entangled in fur, it prevents the animal heat from escaping.

Thus we see why it is that long-haired furs are so much warmer than those of a shorter character. They entangle more air, and consequently interpose more of a non-conducting medium between the animal and the external cold. Even in these cases, such as the seal-skin, in which ladies so rejoice, where the fur is apparently short, the individual hairs are really found to be long, but curled and twisted so as to occupy less space, while holding the same amount of air. A familiar example of the value of air as a non-conductor of heat, may be seen in the conduct of birds when exposed to severe cold.

Take, for example, the redbreast—a bird peculiarly sensitive to cold, and so bold as to be easily ap-

proached. See what the redbreast looks like in the winter, as he sits disconsolately on a bough, or crouches about on the ground. He is hardly recognizable for the trim, smooth-feathered bird of the summer time. All his plumage is puffed out until he looks a mere ball of feathers. In fact, the poor bird is suffering from cold, and instinctively erects all its feathers, so as to entangle as much air as possible between them.

It is evident that the "set," whether of hair or feathers, has much to do with the capability of entangling air; and that anything which interferes with the orderly arrangement of the fibres, will equally interfere with the cold or water-resisting power. I think that in this respect much depends on life. Take, for example, a common water rat, as it comes out of the water, and capture it on shore. It will be found that although the exterior of the fur be wet, the skin is quite dry. But, if the same animal had been shot while in the water, it would have been wet to the skin when taken out.

It is to this fact that is due the fearful cruelty committed by professional cat stealers. We have most of us heard the shameful details of cases where the delinquent has fortunately been brought to justice, and seen that the heartless miscreants always excused themselves for flaying cats alive, by saying that their skins were worth nothing if taken from them after death.

We can now understand why the young polar bear which has been lately mentioned, was so nearly drowned. The dust and dirt that had worked their

way into its fur had interfered with the set of the hairs, and had allowed the air to escape, and consequently the water to get in. Take, again, the familiar example of a sponge. Sink it below the water without pressing it; let it remain for a few minutes, and then remove it. Scarcely a drop of water will have penetrated to its interior. Bubbles of air will be seen at the mouth of every aperture, and will have acted as effectual barriers to the water. Sink it again for half a second, but squeeze it at the time, and then loosen it. On removing the sponge it will be found filled with water, the air having been expelled by the pressure.

Now, every one who has watched the gambols of the Water shrew in a stream, has been struck with the beauty of its appearance when diving. It seems to be enveloped in a suit of silver spangles, and this appearance is due to the innumerable air bubbles which are entangled among its hairs, and which glitter just like those of the sunken sponge. So firmly are they held among the hairs that the rapid movements of the animal through the water do not dislodge them; and they alter its appearance so completely, that when the Water shrew emerges and goes pattering along the bank, it is hardly to be recognized as the same creature which was but a moment ago gliding beneath the water; the velvet-black of its dry coat contrasting curiously with the silvery suit which it wears while submerged.

It has already been mentioned that the sense of hearing is in these animals very acute. That of sight appears to be rather dull, or perhaps it is incapable

of being extended beyond a certain distance. Let the observer only sit quiet, without moving, and the Water shrews will play about within reach of a stick, entirely unconscious of man's proximity. But a movement which produces the least sound at once gives the alarm, and sends the little animals off to their hiding-places.

There is yet another provision of nature which ought to be noticed. In common with many other water trespassers, it has but very small ears. Still, as it is much given to diving—and the water might force its way into the auditory passages—the entrance to the ear is guarded by a valve composed of three little flaps, which are forced together by the pressure of the superincumbent water, and so keep the interior of the ear entirely dry.

There is another British Water shrew, which is called the oared shrew, because the stiff, hairy fringe upon the feet is very hard and conspicuous, looking, while the animal is swimming, like the blade of an oar. It is sometimes called the black shrew, because, although the upper part of the body is of the same velvety black in both animals, the oared shrew is much darker beneath than the common Water shrew. In both species, the tail is flattened from the tip to about one-third of its length, so that it probably serves the purpose of a rudder.

THE DAESMAN (*Galemys Pyrenaica*).

In some parts of Russia and France there are found some curious animals allied to our water shrews, but even more determined water trespassers. Their scientific name is Galemys, and they are popularly known under the name of Daesman.

In many respects, such as the flattening of the tail, the Daesman very much resembles the water shrew, but as it is a much more aquatic animal, its structure is modified accordingly.

Unlike the water shrew, which gambols about on shore or in the water with equal agility, the Daesman spends hardly any of its time out of the water, and is in the fresh water almost as constantly aquatic as the seals are in the ocean. As, therefore, its legs are needed for swimming rather than for walking, they are very much shortened, very little more than the paws appearing outside the skin. The toes are very long in proportion, and are connected with webs, so as to convert the foot into a powerful oar.

It is very much averse to walking on land, and if it be obliged to pass from one stream to another, it will avoid the overland route, and dig for itself a tunnel, the fore feet being adapted for burrowing as well as swimming.

The strangest part of its formation, which enables the Daesman to be a water trespasser, is the shape of the nose. In the ordinary shrew this organ is elongated, but in the Daesman it is so very long and mobile

that it reminds the observer of the elephant's proboscis. Were it not for the peculiar form of this organ, nearly all the Daesmans would perish in the winter time, not from cold, against which they are tolerably proof, but from want of air.

In the winter time, the streams in which the Daesman lives are covered with thick ice, through which very little air can pass. The animal is therefore driven to its burrow, which is a complicated series of tunnellings some twenty feet or so in total length. The mouth of the burrow opens under the surface of the water, and although its ramifications extend upwards, they do not break into the open air like those of the mole. Indeed, even if the Daesman did desire to dig its way into the air, it could not do so, the frozen soil being too hard for its feet.

Its long proboscis of a nose now stands the creature in good stead, for it goes about in search of small apertures in the ground or ice, and by thrusting its nose into them, contrives to breathe where an animal less fitly endowed would, to a certainty, die of asphyxia. Even the Daesman sometimes succumbs, and the animals are found lying dead and suffocated in their burrows.

For frost the Daesman cares but little, being protected from cold as well as from the water by a double coating of fur, like that of the seal, namely, an inner coat of fine soft down, and an outer covering of stiffer hair. The inner coat is so thick and warm that the fur is in great requisition as an article of apparel. It is not only warm, but light, and the only drawback to its use is its costliness, the Daesmans not being very

plentiful, and a great many skins being required for a single garment. The average length of each skin is not more than eight inches.

One of the true moles is called the shrew-mole, and really seems to form a connecting link between the moles and the shrews. Its scientific name is Scalops, which literally signifies a digger, and is given to the animal on account of its burrowing habits.

It has a very long mobile nose, like that of the Daesman, with which animal it is sometimes confounded. Although not so aquatic as the Daesman, it is a water-lover, and swims well, the broad digging feet acting as paddles wherewith it can propel itself through the water. Even the common mole is no mean swimmer, as I can testify from experience, having seen it take voluntarily to the water and swim across a stream.

CHAPTER VII.

Rodent Water Trespassers.

THE BEAVER (*Castor Fiber*).

At the head of the rodent water trespassers, the Beaver at once takes its place as being one of the best swimmers, and possessing the most interesting habits, besides being one of the largest of the whole group. It is rather remarkable that the largest of all the rodent animals, the capybara, is also a water trespasser, though not to such an extent as the Beaver.

The history of the Beaver is a very wonderful one, and there are few animals about whom so many strange stories have been told, some being true and some false, and the former more wonderful than the latter. In the present case, we are only concerned with those details of the animal's economy which enable it to become a trespasser in the water.

The most remarkable part of the Beaver's history is the manner in which it keeps itself supplied with a sufficient depth of water for its purpose when it inhabits a shallow stream. This purpose it fulfils by making a dam, constructed on exactly the same prin-

ciple as that of an ordinary water-mill. This fact has long been known, but the manner in which the dam is constructed has been much misunderstood, and some of the stories respecting the Beaver's powers of building are nearly as fabulous as those of the sailing powers of the nautilus shell.

For example, we used to be told that the Beaver made the dam by cutting long stakes, sharpening one end, driving them into the bed of the river, and then intertwining smaller boughs between the uprights. The work was finished by filling all the interstices with stones and mud, which were brought on their tails, just as a mason carries mortar on a board. The tail was also said to subserve the purpose of a trowel, and to be chiefly used in smoothing and patting down the mud.

As a boy, I was always puzzled to understand how a Beaver should be able to drive stakes into the bed of the river, not seeing where the necessary power could be obtained. I had often constructed dams across streamlets, but could not have driven stakes without the use of a heavy mallet, an implement which a Beaver was not likely to possess. Similarly, being a swimmer, I could not understand how the Beaver could carry mud or stones on its tail, conjecturing, from practical experience, that the weight of the cargo would sink the tail in the water, so that everything upon it would slide off.

On land, the conveyance was supposed to be managed in a different manner. An old Beaver, whose teeth were too much worn to be serviceable in cutting down trees, was utilized as a timber cart. He had to

CUT 6.—BEAVER.

lie on his back, and was then laden with logs, which he embraced with his legs. Several other Beavers then drew him to the spot where the timber was wanted, and so often was this done that many old Beavers had the skin rubbed quite off their backs. If the community were a recent one, and no old Beaver was to be found, they took possession of the first stranger whom they met, and impressed him into their service. The Beaver was also supposed to be unable to live if its tail were dry, so that if it went on shore, it was obliged to go to the river at short intervals, and dip its tail in the water.

There is now before me an engraving representing a party of Beavers engaged in architecture. Their dam is made of strong stakes driven perpendicularly into the bed of the river, and placed quite parallel to each other. Between them are interlaced a number of branches, some of which are so large that they could not have been fixed without the exertion of far greater power than a Beaver can possess.

The real history of the manner in which the Beaver makes itself a home in the water is admirably given in a paper by Mr. A. H. Green, who has been a practical Beaver trapper for some years, and had carefully watched the customs of the animal. The paper was published in the Journal of the Linnæan Society for August, 1869. The following extract is taken from the paper:—

"They begin to build their dams about July or August, as soon as the summer floods begin to subside. For this purpose they generally choose a bend in the stream, with high and clayey banks, and commence by felling a large tree that will reach across the water; or

they fell a tree on each side of the water so as to meet in the centre. They then float sticks from six to four feet long down to the dam, and lay them horizontally, filling in the spaces with roots, tufts of grass, leaves, and clay or mud. The branches of the first tree are the perpendicular supports, almost all the remaining sticks being placed horizontally and crosswise. The last six or eight inches in height is very insecurely constructed, being nothing but mud and leaves.

"The highest dam I ever saw was only about four feet six inches; but the generality of them are not above two or three feet. The action of the water, by bringing down mud, gravel, or fallen leaves, strengthens the dam by making a sloping bank against it; and, the willow sticks of which it is composed sending forth their roots and shoots, the dam in course of time becomes a fixture, bound together as strongly as well could be.

"The winter floods almost invariably destroy the upper part of the dam, which is reconstructed afresh every year. The shape of the dam is almost always semicircular, with the crown of the arch down stream, thus reversing the order of things; but I have no doubt this is in consequence of the heads of the first or principal trees being floated down stream when they are first thrown.

"The body of water raised by these dams varies, of course, according to the fall of the original stream, from a small hole of 20 feet diameter to a lake of miles in length. In the former case, the Beaver builds his house close to the dam, so as to get depth of water, and there saves himself from any hungry panther (*Felis concolor, L.*) or wolf who might feel inclined to

indulge in Beaver-meat. The Beaver also burrows into the banks of streams, always taking care to have two entrances, one under (or close to) the water, and a smaller air-hole on land. With a good dog, capital sport may be had on some of the smaller rivulets leading into or out of a lake.

"The houses are formed of water-logged sticks placed horizontally in the water. They have always two or more entrances, and a small chamber with a little grass for the Beaver to lie on. The top of the house is constructed very thick, to guard against attacks by animals. Mud and roots are used to make the house solid; but no mud is seen from the outside, as the top is covered with loose sticks left there by the Beaver, after taking the bark off. The houses are generally about four feet in height, and about six in diameter on the outside, and would hold about four Beavers, though I have known small houses to hold two only."

It is probable that the two errors respecting the tail of the Beaver—namely, that it is used as a trowel or mortar-board—may arise from the fact that as the animal always trails its flat tail after it as it walks, the muddy sides of the river are worn quite smooth in spots which are much frequented by the Beaver. Then, after it has deposited its load, it has a way of giving a self-satisfied sort of slap on the water with its tail, which has evidently been mistaken for the act of patting down the mud.

As to their mode of carrying the materials used for their buildings, the stones, earth, and similar substances are held firmly between the fore paws and the chin, so that they are upheld by the inflated lungs.

As to trees, the Beavers proceed in a very ingenious manner. They are invariably cut so that the head of the tree falls away from the river. As soon as it is down the Beavers precipitate themselves on it, cut away the branches which are not needed, and drag it into the river so that it can be floated down. They invariably fell trees above, and never below, their dams. To drag a tree up the stream would be beyond the power of any number of Beavers, but to guide it down is a different business, and three or four of the animals are quite enough to pilot a large tree to its destination, taking advantage of every eddy in the stream as craftily as if they were experienced boatmen.

The houses are built in two flats, the lower one being nearly on a level with the water, and used as a landing-stage, and the upper employed as a sleeping apartment. It was at one time thought that the Beaver was in the habit of filling its house with fresh branches by way of a store of food. This, however, is not the case, for, as Mr. Green very rightly observes, a single day's food for a Beaver would more than fill the house. Their stores are generally made at some distance from the dam, and above it, and when the animal has stripped the bark from the branch, which forms almost its sole food, it throws the peeled branch into the stream, and utilizes it either for its dam or house.

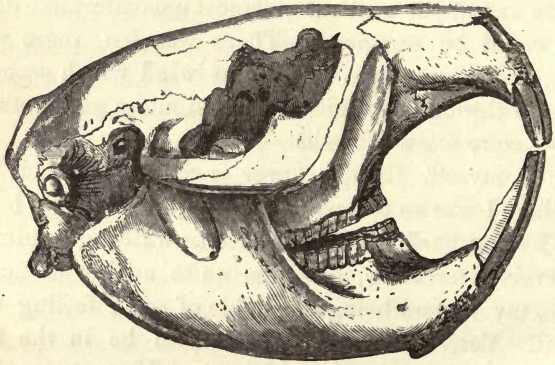
It is evident that the Beaver, which spends so much of its time in the water, must possess some kind of clothing, whether of fur, scale, or feather, which will protect its body. In point of fact, hair, scales, and feathers are only modifications of the same development of the skin. In common with many other water-

loving mammals, they have a double coating of differently formed hairs. Next to the skin comes the close, soft hair, of which beaver-hats are made, and over that is a thatching of longer and coarser hair.

So effectual is this double protection that the Beaver seems to be absolutely indifferent to temperature. Some years ago, when I had the curiosity to visit the Zoological Gardens in the depth of a severe winter, I was greatly interested in the behaviour of the Beaver. It was one of the nastiest and most uncomfortable days that could be imagined. There was ice, there was sleet, and there was a north-east wind which seemed to drive through the thickest and stoutest garments as if they were mere cobwebs.

For myself, though never caring very much for weather, I was so completely chilled to the very bone that I could hardly have patience to watch any animal, however interesting, and was quite unable to make notes, my fingers being incapable of even feeling the pencil. Yet, the Beaver seemed to be in the full exultation of an enjoyable existence. He was popping in and out of his house, running round the edge of his little pond, biting a stick or two with his chisel-like teeth, and ever and anon plunging into the water with a loud slap of his tail, and disappearing below the surface. Presently, he would reappear, scramble upon land, and resume his walk, apparently unconscious of the fact that he was trailing with him a number of lumps of ice that had become entangled with his fur. I felt horribly envious of a creature who could enjoy itself by swimming about in water that almost froze one to look at.

It may at first sight appear rather strange that the possession of very large teeth should be necessary in order that the Beaver may retain its position as a water trespasser. Yet, were it not for these wonderfully powerful weapons, the beaver would soon perish off the face of the earth. A certain depth of water is absolutely necessary for its existence; this depth cannot be secured without the use of dams; and dams cannot be made without the assistance of teeth that



SKULL OF BEAVER.

are large, sharp, and powerful enough to fell the trees which make the foundation of the dam, to cut off the boughs, and to strip them of the bark. These teeth are, therefore, even for a rodent animal, of very great size and strength. They are so powerful that they can cut in two with a single bite a strong walking-stick, and the grooves which they leave upon the trees are so deep that they are often mistaken for the marks cut by the Indian tomahawks.

The strength and size of the teeth may be judged

from the preceding figure of a Beaver's skull. This figure was drawn for my "Illustrated Natural History," published by Messrs. Routledge and Sons, and is kindly lent by them.

There is one remarkable point in their internal structure, the object of which is not precisely known. The cavities of the heart are very large in proportion to the size of the organ, then the walls are quite thin, and when the animal is dead, the heart seems to collapse almost into nothing.

Perhaps the reader may not be aware that the Beaver, although it is chiefly known as an inhabitant of North America, still exists in several parts of Europe, and, until a comparatively late period of history, was found in this country, and was called in Scotland the broad-tailed otter. I believe that it was not fairly extinct until the end of the fifteenth or the beginning of the sixteenth century.

It is a notable fact that in the historical records of this country, the fur of the Beaver was not only more costly than that of any other British animal, but regularly increased in proportionate value, showing that the animal was gradually becoming scarcer. The last specimens were seen in some of the Scottish lakes, and I think that it would be a good work to procure a number of specimens, whether European or American, and try to re-introduce this curious and interesting animal.

It has already been mentioned that the mental qualities of the Beaver have been much exaggerated, in consequence of the erroneous ideas which were prevalent respecting its mode of life. But truth is, indeed,

often stranger than fiction, as may be seen from the following anecdote which is given by Mr. Green :—

"In a creek about four miles above the mouth of Quesnelle River, in British Columbia, some miners broke down a Beaver's dam, in the course of the operations for making a ditch, at the same time erecting a wheel to force up the water. Beavers abounded in this stream, and found themselves much inconvenienced by these proceedings. Accordingly, it is said that, in order to stop the wheel, the Beavers placed a stick between the flappers, in such a way as to stop the revolutions of the wheel. This was so continually repeated night after night, and was so artfully performed, as to preclude the possibility of its being accidental."

Although it is not true that the Beaver must always have its tail wet, yet the auimal does not seem to thrive unless it can obtain access to water. It has often been kept on land and supplied with food, but its natural instincts lead it to perform many of the acts which it would perform if at liberty. For example, if kept in a room, it will collect articles of furniture and make a sort of dam with them in a corner, although there may not be a drop of water in the room. Sometimes it has found the necessity for dam-building so strong, that, not being able to find any loose furniture, such as brushes, or even waste-paper, it has supplied itself with building materials by gnawing off the legs of the chairs and tables. In one such case, the Beaver laid all the furniture prostrate in a single night, having cut off all the legs of every chair and table.

Water seems to be even a matter of health with the animal. Mr. Green mentions a specimen that was

kept at Fort M'Leod. By degrees it became blind, but if allowed access to the water, it always used to bathe its eyes, and in a short while recovered and maintained its sight as long as it could wet its face.

THE WATER RAT, OR WATER VOLE (*Arvicola Amphibius*).

Although, as has just been stated, the beaver has long been extinct in England, we still retain some of its relatives, one of which shares with it the power of trespassing upon the water. This is the well-known Water Rat, as it is popularly called, or the Water Vole, as it is more rightly named. At first sight, and as it is seen running along the banks of the stream, it certainly has a very rat-like appearance.

But if a common rat and a water vole be placed side by side, they will at once be seen to be two entirely distinct animals. The former has a long and sharp nose, capacious ears, and a very long tail; whereas the latter has a short head, with a blunt, rounded muzzle, short ears, and a tail quite insignificant when compared with that of the land rat. The fur, too, is of a different texture, as can be seen by comparing them under the microscope.

Like the beaver, the Water Vole does not flourish when away from its favourite element, to which it always retreats when in danger. The land rat can swim and even dive, as I have witnessed in a case where a barn rat was driven into a pond by dogs, and very nearly escaped by diving. It could not, however, remain below the water for any length of time, and was so exhausted for want of breath when it came to

the surface, that it fell an easy victim. It could also see under the water, as was evident from the fact that it made for a wooden stake which had been driven into the bed of the pond, and clung to it for some little time.

The Water Vole, on the contrary, if it once got an opportunity of diving, would at once have made for the bottom of the pond, and then would have skirted the edge, until it found one of the burrows which were tolerably sure to lead into the water.

These burrows are made on just the same principle as those of the beaver, their entrance being well below the surface of the water, and the extremities well above the highest point to which the water can reach. How numerous are those burrows very few people know. A stream may appear to be absolutely free from Water Voles, while both banks are literally riddled with their holes. This fact may be ascertained by anyone who chooses to take the trouble of wading along the banks and feeling for the rat-holes.

During my boyhood I was much addicted to crayfish hunting. This is rather an exciting sport. You wade along the river bank, and with the fingers test every inch of it as low as can be reached. There will be plenty of rat-holes, especially in those parts which are edged by willows, whose roots hang in the water like great tufts of long red hair, as of a giant's beard.

Under the cover of these roots the Water Vole loves to place the entrance of its burrow, and it is in such places that the crayfish makes its haunt. A little practice soon enables the crayfish hunter to detect his prey. He pushes his hand into the burrow, and if his fingers are pricked, he knows that it is by the spiky

CUT 7.—WATER VOLE AND WATER SHREW.

projections of the crayfish's head. By a quick movement he catches the crayfish by the long antennæ, jerks it out of its hiding-place, and transfers it to his basket, if he takes the trouble to carry one. At Oxford, where the Isis and Cherwell swarm with crayfish, we never troubled ourselves about baskets, but always put the crayfish in our caps.

No one who has not had a similar experience can form any idea of the manner in which the banks of streams and ditches are perforated with the burrows of the Water Vole. Many are disused, but are occupied by squatters, such as the crayfish already mentioned, the water shrew, and even the kingfisher, when an entrance to the burrow can be found above the surface of the water.

Another point in which the Water Vole agrees with the beaver is the vegetable nature of its food, which consists almost entirely of the bark of reeds, mare's-tail, and other aquatic plants, though the animal sometimes makes raids into cultivated grounds, and does some amount of damage to the crops. Such an event as this is, however, a rare one, and a single barn rat will do more harm to the agriculturist than a hundred Water Voles.

Sometimes, however, the Water Vole does become a mischievous animal, though in another manner. There is no great harm in its burrows when they are made in the banks of streams or ditches. But when they perforate the banks of artificial pieces of water, they have been known to weaken the restraining walls to such a degree that they have given way. In some places the Water Vole becomes a constant danger to

reservoirs, for if the water once forces its way even through so small an aperture as a rat's burrow, it enlarges it with increasing rapidity, and soon cuts a large channel for itself.

Even in a small way the animal may become a great nuisance. The late Mr. Waterton had for many years a pond in front of his house. The Water Voles inhabited the banks of this pond, and were continually boring their tunnels, so as to let out the water into a neighbouring stream. He could not extirpate them until the herons came and built in the ground, when the birds soon found out this fertile source of food, and demolished the intruders.

THE CAPYBARA (*Hydrochœrus Capybara*).

It is a rather remarkable fact that the largest of all existing rodents should be a partial water trespasser; so much so, indeed, that whenever pressed by danger, it always rushes to the water for safety. It is a native of South America.

Like most of the swimming animals, its feet are webbed. With these feet it makes wonderful way in the water, and, clumsy as it looks, can dive and swim with such speed that no ordinary foe can overtake it. The flesh of this animal is very good, and it is therefore much hunted by the natives. Its speed and agility in the water, however, are so great, that they could have but little hope of securing it but for the terrible wourali poison with which they cover their arrows. These weapons are five or six feet long, so that they can not only force their way through the

luxuriant foliage that fringes the banks of South American rivers, but can be driven with sufficient strength to penetrate the singularly tough skin with which the Capybara is guarded against the effects of the water.

This skin is so strong that it almost deserves the title of hide, and is the only material known that will resist the spear-like points of the agave plant. Yet the hard wooden point of the long arrow can be driven into it, and if it only penetrate for an inch, the fate of the animal is sealed.

The point is flat, and cut with a series of barbs. It is quite independent of the arrow, being slipped loosely into a square hole at the end of the shaft. As soon, therefore, as the animal feels the wound, it springs forward, and shakes off the shaft, the head remaining in the wound. The effect of the wourali poison with which it is covered is very remarkable.

It produces an almost instantaneous insensibility. The creature seems to be seized with irresistible drowsiness, which increases momentarily; and, though it may not die at once, it cannot exert itself, and so falls a victim to its pursuers. Mr. Waterton states that if birds be but slightly wounded with the tiny blow-gun arrow, the point of which is no longer than that of an ordinary darning needle, it can seldom fly more than a yard or two; but sits nodding on the branch until it falls to the ground. I have only seen one animal die from the effects of the wourali; and, though the arrow did not penetrate a quarter of an inch into the hip, the creature never moved, but dozed off into death by imperceptible gradations.

So, by using this potent weapon, the native hunter neutralizes the water-trespassing powers of the Capybara, and either prevents it from reaching the water at all, or compels it to float helplessly along the stream so as to be easily secured.

Like many other water trespassers, it is so constructed as to be able to conceal nearly the whole of its body below the surface, only just permitting its nostrils to be out of the water. And it takes advantage of every piece of cover, such as a patch of weed, the shade of an overhanging branch, or a tuft of herbage floating down the stream. Under their protection, it just lifts its nostrils above the surface of the water, takes breath, and again sinks. And, as it sees perfectly well under water, and need only take breath at intervals of seven or eight minutes, the water is evidently the safest place for it.

It is mostly a nocturnal animal, moving and feeding by night; and by day lying asleep in the herbage of the river bank, and within a few paces of the water. The foliage is so dense that scarcely any eye but that of the native hunter could detect the animal; and scarcely any weapon but the poisoned arrow could secure it. Even the rifle ball might be turned aside from a vital part, and so give the Capybara a chance of escaping; whereas, it does not matter where the arrow strikes, provided it only penetrates through the skin.

No one, in looking at the animal, could imagine its prowess in the water. On land it looks so very much like a pig, that it has received the name of Hydrochœrus, *i.e.*, water pig. It is thick-bodied, has short and stout limbs, very little ears, and a peculiarly

blunt, rounded, and thickened muzzle, that has almost a ludicrous aspect when seen from the front.

The fur is very thick, and serves to defend the animal from the action of the water. I possess a quiver, given to me by the late Mr. Waterton, which well illustrates the water-resisting power of the Capybara's clothing. In order to preserve its efficiency, the wourali poison must be kept dry; which, in a country of almost perpetual moisture, is a matter of no small difficulty. The native hunters never lose an opportunity of drying their poison, whether in store or upon the weapons; and, as soon as they light a fire, they are sure to place their weapons and wourali gourd close to it.

It is to the extreme care which has been taken in preserving the dryness of the wourali, which Mr. Waterton brought from Guiana some sixty years ago, that its present potency is to be ascribed. I have seen many descriptions of experiments with wourali, both in England and France (there called "curara"), but they have all been unsatisfactory, except those which were made with Mr. Waterton's poison. I am perfectly certain that my own poisoned arrows are just as venomous now as they were in 1812, when Mr. Waterton procured them from the natives.

Now, as it often happens that in Guiana the hunter has to travel for days through water up to his knees, it is of the last consequence that he shall preserve his poisoned weapons absolutely dry. This is achieved by placing them in a quiver woven from a split rattan, and covered with a pitch-like cement. The cover is made from a circular piece of Capybara skin, with the

fur still on it. While still warm and fresh from the animal, it is worked over a wooden mould, much as a felt hat is made at the present day, so as to make a circular cover for the quiver.

The hair is inside, and not outside, as might be imagined. But the native hunter knows what he is about. In the first place, the presence of the stiff, coarse hair serves to retain the cover in its place when screwed on, as it were, with a rotatory motion; and in the next place, not a particle of water can pass through the hairs thus compressed together. Rain has no effect upon it, neither has dew, or the drippings from moisture-saturated leaves. Even if the quiver should perchance fall into the water, no harm would befal it, and it would float away as lightly and as free from water as a corked bottle. It might lie in, or rather on, the water for a week, and the enclosed weapons would be as serviceable as when they were first shut into it.

The use of these hairs to the animal can easily be seen by watching the Capybara in the water. As it swims about, in spite of the graceful ease of its movements, it looks as if its long clothing of coarse hair must be very unpleasant when it comes on shore. After it has swum about for some time, it clambers up the bank, when the water pours off its hairy clothing like rain off a thatched house, leaving the animal as dry as are the rooms of the house in question.

The Capybara does not seem to care particularly about the quality of the water, and may often be found near the mouths of tidal rivers, when at time of flood,

the water is almost as salt as that of the sea. The animal has but very little tail, the steering, as well as the chief power evidently resting in the hind legs. The average length of the Capybara is about three feet seven inches; and it is so stoutly made, that, while it is on land, its abdomen nearly touches the ground. It extends over a very considerable portion of South America; and wherever a river exists, there will the Capybara be found.

THE COYPU RAT (*Myopotamus coypus*).

In Chili there is an animal which has some relationship to the capybara, and possesses many of its habits. It is one of the Water Trespassers, spending a considerable portion of its time in that element, and propelling itself almost wholly with its hind feet, which are very broadly webbed.

Like the capybara, it is protected by a double coating of hair, by means of which the water is excluded from actual contact with its skin. This double coating is useful in commerce, and has of late years attained quite a celebrity under the name of Nutria, or American Otter.

One of the most curious points in the structure of the Coypu, is the manner in which the mouth is modified so as to enable the animal to become a temporary denizen of the water. The incisor teeth are always large in rodents, but in the Coypu they are simply enormous when compared with the size of the animal. They are, in fact, so large that the lips cannot be

closed over them; and the mouth is, in consequence, perpetually open.

This would not matter very much in a terrestrial quadruped, but as the Coypu is semi-aquatic, passes much of its time in the water, and also swims with its body almost entirely submerged, the water would run down its throat as it swims, and thus prevent it from swimming for any length of time. On opening the mouth, however, a most curious structure is seen. The palate is modified into a soft cushion-like projection, which is covered with hair, and which passes behind the teeth, so as to close the aperture.

Nor is this all. In most animals the glottis, or entrance to the wind-pipe, opens into the back of the mouth; although, as with mankind, it can be connected at will with the nostrils, so as to allow of respiration through them. The Coypu, however, has no choice in the matter; the glottis opening into the cavity which leads to the nostrils, so that it could not breathe through its mouth even if it wished.

Thus, there is a double protection to the lungs from being filled with water: the projecting palate forming the first line of defence, and the structure of the glottis the second. If the water were to flow down the throat only, and find its way into the stomach, much inconvenience would ensue, but that is all; whereas, life would be endangered if water were to find its way into the lungs.

We see, therefore, that the stomach is protected from water by a single line of defence, namely, the projecting palate; and no great harm would happen even if a drop or two of water did force their way

through it. But, inasmuch as the presence of water in the lungs would be fatal, a second line of defence is needed, and is found in the manner in which the glottis opens into the nostrils.

One rather curious result ensues from the latter structure. As the glottis does not open into the mouth, as is usual among animals, the Coypu cannot utter any loud or resonant cry, and can only produce a shrill sort of whistle through its nose.

The fondness of the animal for water is an integral part of its nature; and even if it be only supplied with a basin full, it will be dabbling in it all day. Like many of the rodents, it uses its fore paws much after the manner of hands; and, if it be not satisfied that its food is pure and clean, the Coypu will take it to the water, dip it, and shake it with wonderful dexterity until its fastidious love of cleanliness is gratified. In its feeding it much resembles the squirrel, sitting upright, and holding its food to its mouth with its fore paws. The hind feet are long, and the toes webbed; these being the chief instruments of propulsion.

THE BEAVER RAT (*Hydromys chrysogaster*).

There are other rodent water trespassers, of which we have only space for two. The first is the Beaver Rat, a native of Van Diemen's Land. It is not nearly so large as the coypu, the former animal measuring three feet in total length, while the latter is only two feet long. The tail of the Beaver Rat too, occupies

much more proportionate space than that of the coypu.

Owing to the strong odour which it exhales, it is often called the Musk Rat, a title which it holds in common with several other rodents. So powerful is this odour, that human beings have often tracked the animal to its hiding-place, simply by means of the sense of smell.

As its form, which very much resembles that of the ichneumon, implies, it is very active in the water, swimming and diving with wonderful agility. It is a terrible foe to fishes, which it can chase and capture in their own element. It is quite as voracious as the otter, which, though a rodent, it resembles in many of its habits. When kept in confinement, it is best fed by placing in its cage a vessel of water, in which are a number of fish. The Beaver Rat delights to plunge into the water, seize a fish, eat it, and then repeat the process. It will in this way consume twenty small fish at a single meal.

In consequence of its otter-like ways, the Beaver Rat is a terrible foe to fish-ponds, and in more than one case nearly the whole stock of a new pond has been devoured before the depredators could be checked.

As is the case with many of the water trespassers, the fore legs are but little used in swimming. They are employed for progress upon the land, and can be used after the manner of hands, for the conveyance of food to the mouth. The principal means of propulsion in the water are the hind legs, which are exceedingly powerful, and furnished with large and broadly-webbed feet. It is a handsome animal, the

upper part of the fur being rich, dark brown, and the lower part a bright, golden yellow. It is in consequence of this colouring that the animal has received the specific name of *Chrysogaster*, or "golden-belly." The generic title of Hydromys signifies "water-mouse."

THE MUSQUASH (*Fiber zibethicus*).

This is another of the many animals that are popularly called by the name of musk rat. The animal, however, to which that title ought to be restricted is the Sondeli, or Musk Rat of India (*Sorex murinus*), which, however, as its generic name imports, is not a rodent, but one of the shrew tribe, and closely related to the water-shrews, which have already been mentioned. None of the other animals which are called musk rats possess an odour nearly so powerful as that of the sondeli, which, if it should find its way into a cellar, will render the wine undrinkable whenever it passes over a bottle.

The Musquash is a native of North America. It is about two feet in length, exclusive of the tail, which is about ten inches long. As in the coypu, the fore feet are small, and but little used in swimming, this task being entrusted to the hind feet, which are very long, and so broadly webbed that persons who are not acquainted with the animal, and who see its foot-prints on the muddy banks of the river in which it is accustomed to disport itself, are nearly sure to mistake the traces for those of some duck.

The animal is one of the partial trespassers, and is beautifully adapted to the semi-aquatic life which it

leads. Except when pressed by hunger, it is scarcely ever seen except in the water or on the river-bank; and even when on shore it is protected from its many foes by its assimilation in colour to the locality which it frequents.

When it leaves the water and sits on the river-bank, it has a way of remaining in a crouching sort of attitude, and sitting absolutely still. As long as it does not move, it bears so exact a resemblance, both in colour and outline, to a lump of wet mud, that even if it be pointed out by an experienced musquash hunter, it can scarcely be distinguished from the mud on which it is squatting.

On land its movements are not remarkable in any way, but when it is in the water the grace and swiftness with which it is endowed are really wonderful. It is so quick and active that no hunter would dream of shooting at it except from behind, for its watchful eyes are sure to see the flash of the gun, and before the bullet can reach it, the animal has dived, leaving the missile to skim uselessly over the protecting water.

This may seem strange to those who have not had practical experience of the singular protecting power of water against a bullet. There is no need for the animal to descend to any great depth to be secure against fire-arms. An inch will render it almost safe, and two inches absolutely so. Indeed, if the bullet has even to touch the water, the animal below it is tolerably secure, for a bullet which strikes the water obliquely does not enter it to the depth of half-an-inch, but rebounds just like a stone when boys are playing at "ducks and drakes."

If any of my readers have seen artillery practice at a sea-mark, they will appreciate the protecting power of the water. Even the enormous shot of the present day, which are capable of being driven through the thickest and strongest iron plates that have as yet been made, go lightly skipping over the water in almost a playful manner. They do not enter it, but make a series of leaps over the surface, driving up at each jump a perpendicular column of water, and not sinking until the initial force is nearly expended.

When I was a boy, I remember being present at a pike-shooting party. There was a tolerably large sheet of water, which might almost be dignified by the name of a lake. On calm, warm summer days, the pike with which it abounded were in the habit of floating at the surface, either asleep or basking in the sunshine. Now and then the proprietor of the lake used to get together a few friends, and have a few hours' sport in shooting at the fish as they lay asleep—presupposing that fish ever do sleep, which some people think to be doubtful.

To shoot a sleeping fish may seem a very unsportsmanlike proceeding to those who are accustomed to despise a "sitting" shot, but, in reality, a fish was never hit without the utmost accuracy of aim on the part of the marksman. Scarcely any part of the body projects above the surface of the water, and unless that part be struck, the fish escapes unhurt. I have often seen the charge take effect all round the sleeping pike, and yet, although the water was driven up in showers by the shot, the fish escaped unhurt.

As to the Musquash, when once it dives, the hunter

will see no more of it for a long time. It always makes for its burrow, which opens into the water, and has several entrances, so as to allow the animal to enter or leave it at several points. The burrow runs for a considerable distance, and, as is the case with most animals which dig tunnels in the banks of rivers, it slopes upwards, so that the sleeping chamber is far above the highest point which the water is likely to reach. When the Musquash dives, it always gives the water a slap with its tail, very much after the manner of the beaver.

I have, in the course of this brief narrative, mentioned that there are men who systematically hunt the Musquash. This is done for the sake of its fur, which, like that of many other water trespassers, is of a very fine quality. According to the usual structure among such animals, there are two coats of hair—the outer being coarse, and the inner thick and fine, very much like that of the beaver. As the animal is wary and active, the hunters seldom employ the gun, partly because so much time is wasted in getting a shot, and partly because the skin is injured if the animal be struck anywhere except on the head.

The fur-hunters, therefore, place their chief reliance in traps, just as they do when they hunt the beaver. These traps are made of iron, and are not fixed, but so placed that as soon as the Musquash is caught, its struggles bring it into deep water, where it is sunk by the weight of the trap and drowned.

Audubon, who was practically familiar with these cunning rodents, mentions that if the animal be not at once sunk when trapped, its companions gather round

it, and tear their luckless comrade to pieces. This mode of procedure is familiar to naturalists, as it is shared by other animals. Rats, for example, always devour a wounded comrade, and so do wolves. Several species of birds and insects also act in the same manner.

At first sight, this modification of instinct seems to be a cruel one, but, in reality, it is peculiarly merciful. The injured creature *must* die, and it is certainly more merciful to destroy it with a sudden and sharp pang, perhaps scarcely so painful as that which it is already enduring, than to allow it to die a lingering death of hunger, thirst, exhaustion, and slow agony.

The animals, in fact, do by instinct that very act to which an American Indian, tied to the stake of torture, tries to urge his foes. While being slowly tortured to death by foes who exhaust all their treasures of invention and tradition by sparing life as long as possible while adding torture to torture, the captive warrior loads his enemies with jeers and taunts, endeavouring to goad their savage nature into dashing out his brains in a fit of rage, and so ending his agony and his life together. So, when crucifixion was an acknowledged mode of punishment, the friends of the criminal would try to find some mode of killing him as he hung on the cross, instead of leaving him to perish with sheer pain.

So, in later days, when the wheel and the stake were in vogue, the sufferer used always to attempt to bribe his executioner into shortening his pangs—in the former case, by administering the "coup-de-grace," or blow of mercy, as it was rightly called, as soon as possible; and in the latter, by providing dry

and well-seasoned wood, so as to raise a fierce flame which might almost instantaneously destroy life, and by attaching bags of gunpowder to the vital parts of the body. This was not cruelty, but pure mercy, and so is the action of the animals who fall on a wounded comrade and tear or peck him to pieces.

M. Audubon, however, makes another statement concerning the Musquash, which is of a very startling nature. We are not surprised to hear that when a Musquash is caught in a trap, it should be killed by its companions. But we are very much surprised to hear that the animals can exercise discretionary powers, and act in a totally different manner if their comrade be wounded and at liberty, to their conduct when he is wounded and captured in a trap. Audubon states that if a Musquash be shot and not at once picked up, it is carried off by its comrades and removed to a place of safety. This is a most remarkable statement, but I believe it to be a perfectly true one; and it throws quite a new light on the mental character of the lower animals.

CHAPTER VIII.

Pachydermatous Water Trespassers.

THE HIPPOPOTAMUS.

We now come to a group of animals which contains the largest terrestrial mammalia that the world produces. Sometimes they are called Pachydermata, or thick-skinned animals, in consequence of the very great thickness of the hide in many species. That the term is well deserved is evident from the fact that there is now before me a piece of hide which I myself cut, with a saw, from the shoulders of a wild boar. Even in its dry state it is almost two inches in thickness, and it is very much harder than a piece of oak of the same dimensions.

Some systematic naturalists gather them into one large family, called Elephantidæ, in which they included elephants, tapir, hyrax, hippopotamus, and swine—each of these smaller groups forming a separate subfamily.

Most of them are extremely fond of the water, and some may claim to be ranked among the water trespassers. Among these the elephant cannot be named,

because, although it is very fond of the water, and cannot be happy without either a plunge or a douche bath, it does not fly to the water for shelter when alarmed, neither does it obtain its food therein. We therefore pass the elephant by, and proceed at once to the typical water trespasser among them—namely, the Hippopotamus.

I was much struck, when reading Topsel's "History of Four-footed Beasts," with a remarkable point in the history of the Hippopotamus. This book was published more than two hundred years ago, and in it are several curious examples of scepticism and credulity. The latter quality is shown in the accounts which the author gives of certain fabulous animals—such as the satyr, the lamia, the sphinx, the sea-serpent, etc.—all of which are described in perfect good faith, the descriptions accompanied by illustrations as remarkable as the letterpress.

The reader may perhaps remember that, almost within the memory of living men, the existence of the giraffe was stoutly denied by the learned, while no doubt was expressed about the Hippopotamus.

Yet in Topsel's book the opposite course is pursued. The author gives two figures of the giraffes rather exaggerated, especially about the horns, which in one figure are made like those of the ibex, but figures which very fairly express the shape of the animal. They are evidently drawn from the living animal, and give the peculiar sloping shoulders, the shape of the tail, and the form of the hoofs with perfect accuracy.

The writer also describes the very long and pre-

hensile tongue: "His mouth but small, like a hart's; his tongue is near three feet long, and with that he will so gather in his meat that the eyes of a man will fail to behold his haste." Topsel, also mentions the peculiar gait of the animal, the legs of the same side being moved together. Yet one hundred years afterwards, the animal was considered as a myth, and any travellers who mentioned it were denounced as liars.

It is very remarkable, therefore, that Topsel, who gave so accurate an account of the giraffe, should be incredulous respecting the existence of the Hippopotamus. For his figure of the animal he gives the well-known allegorical painting in the Vatican, which represents a hippopotamus with a crocodile in its mouth, and signifies the river Nile. His remarks on the subject are worthy of notice.

"The sea-horse, called in the Greek *Hippotomos*, and in Latinæ *Equus fluviatilis*. It is a most ugly and filthy beast, so called because in his voyce and mane he resembleth a horse, but in its head an oxe or a calf, in the residue of his body a swine; for which cause some Grecians call him sometimes a sea-horse, and sometimes a sea-oxe, which thing hath moved many learned men in our time to affirm that a sea-horse was never seen; whereunto I could easily subscribe (saith Bellonius), were it not that the antient figures of a sea-horse altogether resembled that which is here expressed, and was lately to be seen at Constantinople, from where this picture was taken.

"It liveth for the most part in *Nilus*; yet it is of a doubtful life, for it brings forth and breedeth on the land, and by the proportion of the legs it seemeth

rather to be made for going than for swimming; for in the night time it eateth both hay and fruit, forraging into corn-fields and devouring whatsoever cometh in the way; and therefore I thought it fit to be inserted into this story. As for the sea-calf, which cometh sometimes to land only to take sleep, I did not judge it to belong to this discourse, because it feedeth only in the water." (I presume that Topsel here refers to the manatee.)

"The picture was taken out of the Colossus in the Vatican at Rome, representing the river *Nilus*, and eating of a crocodile; and thus I reserve the further discourse of this beast unto the History of Fishes, adding only thus much, that it ought to be no wonder to consider such monsters to come out of the sea which resemble horses in their heads, seeing therein are also creatures like unto grapes and swords."

One of the most remarkable points about the Hippopotamus is its extreme activity when roused to exertion. Under ordinary circumstances it is slow, sluggish, and leisurely in its movements, and has a very great predilection for lying down on shore, or floating motionless on the water. But when roused, its tons of flesh seem to be no impediment, and the huge beast flies as nimbly about as an enraged cat.

The rapidity of its movements on shore has been well shown by the large female Hippopotamus in the Zoological Gardens, against whose fury a variety of precautions have to be taken that seem scarcely necessary when the vast body and short legs of the animal are taken into consideration.

The rhinoceros, an animal closely allied to the

Hippopotamus, affords another example of unexpected activity. Slow and deliberate in its usual movements, it can suddenly charge with lightning-like rapidity, and with such terrific force that one of these animals has been known to strike its horn completely through the body of a horse as far as the saddle on the opposite side, and to throw the horse a complete somersault.

Then, to compare small things with large, there is the hyrax, or rock rabbit, the "coney" of Scripture, which, in spite of its smaller size, forms a connecting link between the rhinoceros and the Hippopotamus. Usually the hyrax is quiet enough, but, if startled, its sudden activity is quite astonishing. I have seen the little animal fly over the wire gratings of the cage with such rapidity that the eye can scarcely follow its movements. Indeed, the jerboa is the only creature I have seen that equals it in this respect.

Neither of these animals continue their rapid movements for any long period, but during the short time of activity their agile quickness is almost preternatural.

In consequence of the enormous bulk of the Hippopotamus, the legs are planted so widely asunder, that when it walks through grass the feet on each side form a distinct line of tracks, just like those of a very fat man when he walks; and that such an enormous mass of flesh should be capable of rapid movement seems almost impossible. A very good perspective view of the animal is given on Plate II.

In the water the activity of the animal is no less surprising than when on land. We have little oppor-

tunity of judging of the animal's aquatic powers by seeing it in the small ponds which can alone be given for its use in this country, but in its native rivers its speed is really wonderful. Sometimes, when angry and pursuing an enemy, it dashes along in a series of bounds, springing half out of the water at every leap, just like a terrified whale. Sometimes it keeps up a steady rush like that of a locomotive on a railway, its deafening snorts and yells increasing the resemblance. Mr. Baines, the well-known African traveller, who had the advantage of being an accomplished artist, made several drawings which exhibit the aquatic powers of the Hippopotamus.

One of these shows the speed at which the creature can rush through the water, even when hampered by a heavy weight and weakened by a wound and loss of blood. It represents a Hippopotamus which has been struck by a native harpooner belonging to the Makoba tribe. The hunters have approached the animal in a canoe which contains several assistants and a steersman. As soon as the creature is struck, it dashes off down the stream at such a pace that the head of the canoe is half buried in the water, and throws up volumes of spray, like the bows of a swift yacht in a smart breeze.

The harpooner and his assistants all hold on to the rope, lying almost on their backs in the boat, and holding themselves with their feet against the sides. Sometimes the pace is too much even for these experienced boatmen, and they are obliged to cast off the rope and wait for a chance of putting in another harpoon.

Sometimes the Hippopotamus turns sharply on the canoe and endeavours to crush it between his enormous jaws, or to drive it out of the water by a blow from his head. Should he succeed in his attack, the men all dive to the bottom of the river and hold on by the weeds or stones until they are forced to come to the surface to breathe. The fact is, that the Hippopotamus cannot imagine the possibility of a foe beneath the water, and therefore never thinks of looking for enemies anywhere below it. As soon as he has smashed the canoe, he raises his head as high out of the water as possible, and if he cannot see anything alive on which to wreak his vengeance, he goes off, satisfied with what he has done.

Mr. Baines most kindly placed all his sketches at my disposal, and I have transferred three of them which represent the Hippopotamus hunt to my "Natural History of Man," published by Messrs. Routledge and Sons, vol. 1, pp. 380—383.

Although the Hippopotamus can live without access to water, it does not thrive properly, and even the very character of its skin becomes altered. This was shown by the male Hippopotamus which was sent to England in 1850, and which created such a sensation. During its long travels from Egypt to the Zoological Gardens, it could not bathe properly, and could only have the comfort of a few buckets of water poured over it daily. When it arrived it was about as large as a prize hog, and was quite mild and tame, being quite demonstratively affectionate towards its keeper, a young Arab lad named Salama, who called his charge by the name of Buckeet, *i.e.*, the Lucky One. Mr. F.

Buckland wrote at the time an interesting account of the animal, which was published in the "Field" newspaper. The following is an extract from his letter:—

"From not having been able to have a bath for six weeks or more, his skin had assumed a curious appearance. The back, instead of being soft, shiny, and indiarubber-like, was quite hard and dry, and the skin was peeling off it, as from the bark of a tree. His back, in fact, was much more like a bit of an old forest oak than that of a water-loving animal.

"It was, of course, expected that the moment Hippo smelt and saw the water he would rush into it; but no—he merely went up to it and smelt it as though he had never seen it before, and it was not until the Arab advanced himself partially into the water that Hippo would follow. He (like a naughty boy at the sea-side) soon came out again, and was only persuaded to go right in by the Arab walking round the edge of the tank.

"Hippo then began to find out where he was, and how comfortable the clean, warm water was. Down he went to the bottom like a bit of lead; then up he came with a tremendous rush and a vehement snorting; then a duck under, then up again, prancing after the manner of Neptune's sea-horses that are harnessed to his chariot in the old pictures of the worthy marine deity. I never recollect to have seen any creature, either man or beast, so supremely happy for a short time as was poor, travel-worn Hippo after his long voyage of so many thousand miles.

"Coming out of the water, Hippo smelt about for food; mangold wurzel was given him, and mightily

did he enjoy it. Like all young creatures in a strange place, he kept a close eye upon his nurse, and gave a peculiar half-bellow half-cry when he went out of his sight, refusing food till his return.

"Evening soon arrived. Hippo retired to rest by the side of his faithful keeper, who, the next morning, reported that, whereas on ordinary occasions, if he coughed or moved or made the least noise in the night, 'Jamoos' (the Arabic for Hippopotamus) would wake up and answer. The night of his arrival he slept a sound sleep, waking only at sunrise for his breakfast and his bath, which he mightily enjoyed. His skin is now beginning to lose its bark-like appearance; it is getting soft and shiny, and of a black-pinkish colour, and he promises to grow up into a larger beast than his fellow Hippopotamus in the next cage to him; for 'Buckeet' comes from the White Nile, in which river the animals grow larger than in the Blue Nile, from whence the two Hippopotami now in the Gardens were brought."

The slight pinkish hue which is here mentioned is a sign of health. Mr. Baines tells me that when the animals are at liberty in their native river, the ears, nostrils, and ridge over the eyes are of the most glowing scarlet, and not merely pink as they are in the animals kept in captivity.

This brilliancy of colour is very useful to those who hunt the Hippopotamus with fire-arms. As is the case with many semi-aquatic animals, the head is so constructed that the creature can lie for hours with its body submerged, and nothing showing above the surface of the water except its ears, the ridges over the

eyes (the "garret-windows," as Gordon Cumming calls them), and the nostrils. Formerly, it used to be the custom to aim at the eye, because, if it were accurately struck, the shot was almost instantly fatal. Now, however, the hunter aims at the nostrils, for such accuracy of aim is not absolutely necessary, and, if the animal be hit anywhere about the nostrils, it is rendered incapable of remaining below the surface, so that it falls a comparatively easy prey to the bullet. Three pairs of bright scarlet spots are seen on the surface of the water, indicating the positions of the ears, the eyes, and the nostrils. The hunter aims between the nostrils, and, unless he is a very bad shot, is tolerably sure to cripple the animal.

The point mentioned by Mr. Buckland about the hide is well worthy of further consideration, inasmuch as it is one of the most important modifications of structure which enable the animal to be a water trespasser. In most of the animals which have been described, the vital parts are defended from the water by a modification of their fur, which forms a water-proof covering. But the Hippopotamus has no hair, so that another mode of protection is needed. This is obtained in a manner similar to that which has been already noticed in the whale tribe.

The body is first covered with a thick layer of fat, which is a bad conductor of heat, and therefore serves to keep the animal warm. This fat is called by the Dutch colonists Zee-koe speck, or sea-cow bacon, and is much esteemed as an article of diet. Over this casing of fat comes the skin, which is about an inch and a half in thickness, and is pierced with innume-

rable pores, through which exudes an oily, slimy sort of fluid, which has the effect of preventing the water from coming into absolute contact with the skin itself.

Soon after "Buckeet" had been established in the Zoological Gardens, I had a talk with him and patted him. I could not at the time but think of Sydney Smith's remark upon some one who was patting a tortoise, and whom he recommended to pat the dome of St. Paul's, by way of gratifying the Dean and Chapter. Unfortunately, I had not removed a pair of new kid gloves, and, to my astonishment, I found the right-hand glove hopelessly spoiled, being saturated with the dark, oily secretion of the skin.

Another point about the skin is its wonderful flexibility. It is so hard and tough that when removed from the animal, it has to be cut into lengths, like so many planks, and so to be torn off by main force. Its thickness and toughness are well shown by the principal use to which it is put—namely, the manufacture of those terrible "jamboks" or "cow-hide" whips, which are so powerful that each stroke will leave a groove in a deal board, and when employed on the thick-hided draught oxen of Southern Africa, will strike off a strip of skin along the whole back of the animal.

Yet, this skin, thick, tough, and hard as may be, is, when on the living animal, as soft and flexible as india-rubber, enabling the Hippopotamus to perform those feats of agility in and out of the water which have already been mentioned.

Like many other animals which frequent the water,

the Hippopotamus always rushes to that element for safety when alarmed. So strong is this instinct, that even the newly-born cub does the same thing, and if it be disturbed when sleeping, scuttles off at once for the water. It was this instinct which made the task of the keepers at the Zoological Gardens so heavy when the young Hippopotamus had to be removed in order to give it nourishment.

The first time that they tried to get the mother away from her offspring, the little creature plumped after her into the water, and, as it swam as well as she did, and evinced no likelihood of coming out again without her, the attempt failed. When they did succeed, it was by taking advantage of a time when the young one was asleep.

"Buckeet," part of whose history has already been narrated, was captured in a similar manner. The little creature was fast asleep on a bank of reeds during its mother's temporary absence. Mr. Petherick was sailing a boat on the lake, and the owner, who was conning the vessel from the mast-head, saw the sleeping cub. Some of the men got into the water, went quietly up to the little Hippopotamus, and whipped him into the boat before he was fairly awake. After the manner of his kind, he screamed lustily, but, fortunately, his mother was too far away to come to his assistance. He must at that time have weighed somewhere about one hundred pounds.

Mr. Petherick caught no less than four animals in the same way, of which "Buckeet" was the only one that reached England. One died on board, one was thrown into the river when the boat struck on a rock,

and escaped; and the other became entangled in the boat, sank with it, and was drowned.

Having these habits, the Hippopotamus is always watchful to preserve its communication with the river, and cannot endure that anything or anyone should cut off its retreat. On one occasion, when a native hunter had got between the Hippopotamus and the river, the animal was too frightened to be angry. It made headlong for the water, caught the man on its enormous nose, jerked him high in the air, and rushed into the water. Fortunately for the man, it was so alarmed that it did not think of stopping and using its teeth. Had it done so, there would have been no chance for him, as Mr. Petherick once saw a Hippopotamus seize a man and cut him in two with a single bite.

Aquatic as it is, the Hippopotamus does not affect the rapid parts of the stream; and seems to prefer the lake to the river, because there is no stream. It is rather a lazy animal, and likes to lie asleep in the water, if possible, with its chin resting on a bank of reeds, or some such support. Consequently, it prefers, when it awakes, to find itself in the spot which it occupied when it fell asleep; an event which would not take place in a stream, however sluggish. When the animal inhabits a river, such as the Nile, it looks out for quiet bays which are well flanked with reed-beds. In these bays there is scarcely the slightest current, and the animal can repose in perfect quietude.

When very young, the Hippopotamus is carefully tended by its mother. After a while it becomes tired of swimming, and needs rest. Now, the mother could

easily take her little one on shore, but she very much prefers to remain in the river; so she sinks herself in the water until she comes below the feet of her offspring, and then, rising to the surface, she lifts her child on her back, and carries it about wherever she goes. The neck is the usual position for the young Hippopotamus under these circumstances.

THE TAPIR (*Tapirus terrestris*).

There are supposed to be several species of Tapir, but we will restrict ourselves to the two typical examples, namely, the Common Tapir of tropical America, which is figured in Plate III., and the Malayan Tapir (*Tapirus Malayanus*).

These are most valuable animals to the systematic zoologist, as by their means he is able to trace many of the links that bind together the various species of the pachydermata. They scarcely look like modern creatures, so closely do they resemble in form and attitude the extinct animals which we only know by their fossil remains. There is one peculiar, squatting attitude which they are fond of assuming, and which gives them a sort of weird, grotesque aspect that is really startling.

One of the most conspicuous points in the structure of this animal is the extraordinary length of its snout, which is very much longer than that of the pig, but not nearly so long as that of the elephant. And it is a very remarkable point that there are fossil remains of animals in which the snout is gradually lengthened,

TAPIRS, AND CAPYBARA.

so that there is a complete series of links between the elephant at one end of the scale, and the swine at the other.

The upper lip of the rhinoceros is, as we all know, capable of great elongation, and can be worked very much after the fashion of the elephant's proboscis. Indeed, when the rhinoceros desires to feed, it always gathers together the fodder with its upper lip, rolls it into a bundle, and by means of that useful member, tucks the bundle into its mouth.

The same organ of the Tapir is, however, very much more developed; and it can be turned and twisted about in such a manner as to give a wonderful variety of expressions to the animal. Some of these modifications of shape may be seen in the illustration; and, if the reader would like to study the subject for himself, he has only to go to the Zoological Gardens, and offer to one of the animals a little tuft of grass, holding it slightly out of reach. The Tapir will then be induced to protrude its lip to the utmost, and a very curious object it will be sure to be.

Like the hippopotamus, the Tapir is always found in the immediate vicinity of water; and, though not partaking so largely of the amphibious nature, is yet a very aquatic animal. Like the hippopotamus, it always retreats to the water for safety when alarmed, and is a much greater traveller than that animal. The hippopotamus is rather local, and loves to hang about one spot; whereas the Tapir is much of a wanderer, and will make single journeys of wonderful extent, partly by swimming and partly by walking. The specimens in the Zoological Gardens are very fond of

paddling about in their drinking trough, and splashing the water over themselves, in default of a regular bath.

The animal is most useful to the aborigines, who eat its flesh, and employ its singularly tough skin for many useful purposes.

The flesh is, as a rule, tough and stringy; but the jaws of a savage are equal to the mastication of any sort of meat, however tough.

It is not so welcome, however, to the civilised colonists and agriculturists. It has the good taste to prefer grain and garden crops to the wild and comparatively coarse vegetation of its native country, and is rather apt to make great havoc in fields and gardens. Unless cultivated grounds are very strongly fenced, the Tapir will be sure to enter them. Trusting to its great weight to break down the fence, and to its tough skin to keep it from harm, it rushes against the enclosure, and, if it should force its way through the barrier, does infinite harm by treading down as well as eating the crops.

Like the capybara, which inhabits the same rivers, the Tapir is a wonderful adept at hiding among the reeds and foliage of the river-bank. Generally, it lies so concealed through the day, and is so well hidden, that a practised eye is required to detect it. Indeed, so well hidden is the animal, in spite of its large size, that a traveller has often been startled while walking along the banks of a stream, by the sudden rush of a Tapir into the water; the animal having been almost at his very feet before it would move.

It is remarkable, by the way, how completely some of our largest animals can hide themselves, owing to their capacity of resembling surrounding objects. Take, for example, the elephant, the giraffe, and the buffalo. The elephant, although standing some ten feet in height, and weighing many tons, can conceal himself so effectually in a forest, that a hunter may be near enough to touch him with a stick, and yet not even catch a glimpse of his vast form. Not only that, but the hunter may be among a herd of elephants, and never be able to see one of them sufficiently for a shot.

Then there is the giraffe. Any one would have thought that so conspicuous an animal as this, which rears its lofty head some eighteen feet from the ground, must be visible at a great distance; yet, when it is among the trees upon which it feeds, it bears so close a resemblance to them, that not only white hunters, but even the natives, have failed to distinguish them; and have sometimes been so completely deceived as to mistake the trees for giraffes.

As to the buffalo, whether it be the long-horned arnee of India, or the thick-fronted buffalo of Southern Africa, it has a way of concealing itself so that it is quite unseen, and then rushing out angrily at the traveller who happens to disturb it.

I have already alluded to the size and weight of the Tapir. Now, as the animal only averages some four feet in height at the shoulder, it may scarcely seem entitled to be called a large one. But it is very heavily and stoutly made, the body is thick, and the legs are short, so that it is far more bulky than it

appears to be at first sight. The feet of the Tapir are very curiously constructed, so that their prints upon the muddy banks of the river look very much as if they had been made by some gigantic bird.

The Malayan species much resembles its American relative in general habits, except that it seldom, if ever, swims, but walks on the bed of the river.

BABYROUSSA (*Babirussa Alfurus*).

Several of the swine may be ranked among the partial water trespassers, the first of which is the Babyroussa of Malacca.

The male of this animal often grows to a very large size, and is really a formidable being. It is armed in a very singular manner. The lower jaw possesses tusks like those of the ordinary boar, except that they are very much longer—so long, indeed, that they project very far above the upper surface of the snout.

Now, even with his comparatively short tusks, the common wild boar is a dangerous foe. In India, the natives think the animal quite as formidable as the tiger; for it is nearly as active, and can kill a man with a single stroke of its tusks. When, therefore, we see a boar as large as an ordinary donkey, and with enormously developed tusks, it is evident that the animal must be a terrible antagonist, if its activity and courage correspond to its armature.

Besides these tusks of the lower jaw, the Babyroussa possesses a second pair, which proceed from the upper jaw, and which are very curiously formed.

The sockets in which they are developed are curved in such a way as to give the tusks an upward, instead of a downward turn. They actually pass through a pair of holes in the upper lip, and often grow to so great a length, that their points almost touch the forehead. The object of these remarkable tusks is at present unknown, although the fact of their presence is a proof that they subserve some definite purpose. Generally, tusks are used as weapons; but those of the adult male Babyroussa are quite unavailable for this purpose, as the points are so close to the forehead that they cannot make the slightest wound. Indeed, they only interfere with the action of the tusks of the lower jaw.

Some persons have thought that they are intended as safeguards to the eyes when the animal is forcing its way through the thick underwood. Perhaps they may serve this purpose; but that it is not the real object of the tusks, is evident from the fact that the female, as well as the male, has to force her way through underwood, and yet does not possess tusks in either jaw.

The Babyroussa is one of the water-lovers, and has many of the habits which have been narrated as belonging to the tapir and capybara. Like these animals, it frequents the banks of rivers, and hides itself among the foliage. Even when kept in captivity it preserves the habit, and is fond of gathering up the litter into a corner, and then backing itself into the heap with a movement very similar to that by which a crab works its way beneath the sand.

I have often seen a Babyroussa at the Zoological Gardens perform this feat. The animal wriggles its

way perseveringly among the litter; and, when it is satisfied with its position, gives a grunt of satisfaction, and then sinks on the ground. The litter closes over it, and the animal is so perfectly concealed, that even though it has been seen in the act of burrowing, it can scarcely be detected.

If alarmed, it makes for the water, and swims off; and I have been told by a traveller who had been often brought into contact with it, that the animal can swim for a very long distance with perfect ease. Large herds of this formidable animal are often found in the swampy portions of Malacca.

THE BOSCH VARK (*Choiropotamus Africanus*).

The lower figure on Plate II. represents another of the water-loving swine, called by the African settlers the Bosch Vark, or Bush Hog. The generic name of choiropotamus, or river hog, alludes to its aquatic habits, just as does that of hippopotamus, or river horse, to similar habits in another denizen of the same land.

It is a handsome animal, being, unlike the generality of pigs, variegated in colour, the chief hues being ruddy brown and white, and the hair being very long. All these semi water trespassers appear to have very similar habits. They are great adepts at hiding themselves, and will spend a considerable portion of their time in lying concealed among the herbage. Each individual seems to have its regular den or hiding-place, and, if it be disturbed, it rushes angrily at the intruder. Like the babyroussa, the Bosch Vark asso-

ciates in herds, and the natives are always chary of disturbing them, knowing that the wounds inflicted by their tusks are dangerous, and not easily healed.

A very fine specimen of an allied animal, the Red River Hog (*Potamochœrus penicillatus*) was sent to the Zoological Gardens about eleven years ago. This is a native of Western Africa, and is a very handsome animal. The head is enormously long, and so are the ears, which are tipped with a brush-like tuft of long hairs, thus earning for the animal the title of *penicillatus*, or pencilled. These tufted ears are used by the hog much as a horse uses its tail, and are switched sharply about for the purpose of driving away the flies. Putting aside its rather grotesque form, the Red River Hog is a handsome animal, with a rich chestnut coat, a large black patch on the forehead, and a snowy-white stripe down the back.

CHAPTER IX.

Marsupial and Monotrematous Water Trespassers.

YAPOCK OPOSSUM (*Cheironectes Yapock*).

EVEN the marsupial group—*i.e.*, those animals which carry their young in natural pouches—is not without its aquatic representative, which we find in the Yapock Opossum of Tropical America.

This remarkable animal departs in many ways from the structure and habits of its kin. As a rule, the opossums are lovers of trees, traversing them as actively as the squirrels, and securing themselves by their long, prehensile tails, which they twist round the branches after the fashion of the spider-monkeys of the same country. Indeed, so powerful is the grasp of the tail that the animal often feeds while suspended, holding the food to its mouth by means of its fore paws. And if it be shot while hanging, it will often retain its hold until decomposition sets in, and loosens the tense muscles.

They are all predacious animals, and, whenever they find their way to the farm-yard, work terrible destruction among the poultry.

It is, therefore, rather startling to find that there is a species of opossum which cannot even climb a tree, which obtains its prey in the water, whose feet are modified into oars, and whose tail acts as a rudder. Such, however, is the Yapock Opossum, a handsome creature, with a coat of light grey, blotched with great bars and patches of black. All the paws are webbed, but the fore paws have the web extending only as far as the first joints, so that they can be used after the manner of hands. This structure, however, renders them incapable of being employed in traversing the branches of trees, as is done by the terrestrial, or, I may rather say, the arboreal opossum. Even the shape of the animal is unlike that of the other opossums, and, to a practised eye, at once indicates its aquatic character.

The toes of the hind feet are much lengthened, and, as they are webbed down to the claws, they form very effective instruments of propulsion. By their aid, the Yapock can swim so swiftly and actively that it can chase and capture even the fish in their own element, and, indeed, has been captured in a fish-trap. The animal dived into the trap in pursuit of the fish, and, being unable to extricate itself, was drowned.

Aquatic insects, crustacea, and similar creatures, form part of the Yapock's food. Perhaps the nature of its food may have some connection with the curious fact that the mouth is furnished with cheek-pouches, like those of the monkeys. These pouches are very large, extending completely along the side of the head, and are supposed to be given to the animal for the purpose of enabling it to gather a store of water-insects, and to take them home to its young.

Like most aquatic animals of small size, it resides in burrows which it digs in the bank, the opening being beneath the surface of the water.

In this remarkable animal we see, therefore, a most instructive instance of the manner in which a comparatively slight modification of structure can transform an arboreal into an aquatic animal, and enable it to live with completely changed habits. Instead of traversing trees, it swims and dives through the water. It seeks its prey in the river, and not on the shore; and, instead of making its home, as the terrestrial opossums do, in the hollow of a tree, or even usurping that of a squirrel or some other animal that makes a warm and snug nest, it excavates for itself a burrow in the bank of the river, just after the fashion of the common water rat of our own country.

Before leaving the marsupials, I should like to say a few words upon another marsupial trespasser, although it trespasses in another direction. Assuming the monkeys to be the type of arboreal animals, we have the remarkable fact that by very slight modifications of structure, an essentially terrestrial marsupial animal becomes changed into an arboreal trespasser. We have already seen how the arboreal opossum can take an aquatic form, and we shall now see how the kangaroo itself can become arboreal.

I allude to the famous Tree Kangaroo (*Dendrologus ursinus*). This very remarkable animal has the fore paws much longer, and the hind legs much shorter, than is the case with those species which have only to traverse the ground. The black claws are peculiarly long and rather curved.

That a kangaroo should be able to traverse the branches of a tree is so extraordinary a fact that many people refused to believe its possibility until positive proof was given of the animal by a living specimen at the Zoological Gardens. Its cage was fitted with a large tree-branch, such as is supplied to the leopards, and it was a very curious sight to watch the animal skipping about the boughs as lightly and securely as if it had been a squirrel. It retained many of the habits of its wild state, notably that of sitting motionless for long periods, as if asleep, but, when roused to action, leaping about with astonishing quickness.

I imagine that these habits tend to its preservation. The dark-brown colour of the fur bears so close a resemblance to the hue of the branches that, even when the animal is in a cage, and the observer knows where to look, he will not at once discriminate between the tree and the animal. Its habit of stillness will, therefore, account for its preservation from the eyes of enemies, while its exceeding quickness and agility when in motion, will enable it to escape from almost any foe except man.

DUCKBILL (*Platypus anatinus*).

We will now return to our mammalian water trespassers, the last of which is the celebrated Duckbill, called Mullingong or Tambreet by the natives, and Water-mole by the colonists.

Not for a moment could anyone doubt the aquatic nature of the animal, for its thick and water-proof fur, its deeply-webbed feet, and its oddly-shaped head,

which looks almost exactly like that of a duck—all point to the fact that it passes much of its time in the water.

In this animal, as well as in that which was just described, the protection of colour is very considerable. As it floats on the surface of the water, it bears an almost exact resemblance to a bunch of loose weeds, and, as it has a habit of allowing itself to drift with the stream, the resemblance is so close that it can hardly be detected. In fact, it is only when the animal begins to paddle that the slight rippling motion which it makes in the water leads to its detection. As, moreover, it does not expose itself in daylight, but chooses the dusk of the evening for its wanderings, it is rendered still more indistinguishable by the fading light.

Dr. Bennett has given in his "Gatherings of a Naturalist in Australia," a very interesting account of the habits and appearance of the animal, together with an admirable coloured illustration.

In the first place, the stuffed specimens which are usually seen give but little idea of the real form and contour of the Duckbill. The most conspicuous part of the creature—namely, the bird-like beak, is always black, flat, and withered; whereas in the living animal it is rounded, fleshy, and of a pinkish colour. It is used as a tactile organ, and is evidently well furnished with nerves, the animal paddling with it in the mud just as a duck does, and extracting from it the aquatic insects and molluscs on which it feeds. Like the yapock opposum, it is furnished with large pouches on either side of its cheeks.

Dr. Bennett succeeded in capturing several of these

CUT 9.—DUCKBILL.

animals alive, and so had many opportunities of watching their movements. With the aid of some natives, he succeeded in digging a full-grown female out of the burrow in which she lived, and, after it had become a little used to captivity, experimented upon it. Taking the precaution to fasten a long string to its hind leg, he allowed it to swim about in a pond. It at once made for the spot where aquatic weeds were floating, and ranged between them and the weeds of the bank, thrusting its beak among them, and evidently extracting food.

It took no notice of insects which had fallen into the water and were fluttering on the surface, but restricted itself to those which it obtained from the mud. The movements of the beak were noticed to be exactly like those of the duck's bill while feeding. Having no teeth, but only four grooved bony plates which act like mills, it cannot eat hard or large morsels, and this is probably the reason why the floating insects were disregarded.

After a while, it climbed up the bank and began to clean its fur, in which both the hind feet and the beak were brought into requisition—the latter being used just like the beak of a bird among the feathers, and producing a beautiful gloss on the fur.

Stuffed specimens also distort the whole shape of the body. In such specimens the skin is stuffed as full of tow as a sausage of meat, and the body is almost round; but, in the living specimen, the skin is peculiarly loose, and forms a large fold along each side, almost as conspicuous as that of the flying squirrel. In consequence of this structure, the animal can force

itself through an aperture which seems hardly capable of admitting an animal of half its size, and if held in the hand, it can scarcely be retained there, slipping through the grasp in a most uncanny fashion. It feels, as Dr. Bennett says, as if the animal were enclosed in a thick fur bag. When moving on land, the extreme looseness of the skin gives the Duckbill a singularly uncouth appearance, and neither dogs nor cats will touch it, the former barking at it, and the latter running away in alarm.

Dr. Bennett's account of his first sight of a Duckbill is graphic and interesting :—

"The sun was now near its setting, when, at a more quiet part of the river (knowing as I did the crepusculous nature of the animals), I endeavoured to obtain a sight of the shy *Ornithorhynchus paradoxus*. Those only who are anxious to view and investigate the works of nature, either in the peculiar forms of the animals or the surpassing beauty and variety of the vegetable kingdom, can appreciate the sense of enjoyment experienced on seeing in their native country objects which, before, were known only from vague description.

"At a tranquil part of the river, called by the colonists a 'pond,' on the surface of which numerous aquatic plants were growing profusely, or in places of this description, the water moles were most commonly seen, seeking their food among the plants, whilst the shaded banks afforded them excellent situations for excavating their burrows.

"We remained stationary on the banks, with gun in rest, waiting their appearance with some degree of

patience; and it was not long before my companion quietly directed my attention to one of these animals on the surface of the water, not far distant from the bank on which we were then standing. In such circumstances they may be readily recognized by their dark bodies just seen level with the surface, above which the head is slightly raised, and by the circles made in the water around them by their paddling action.

"On seeing them, the spectator must remain perfectly stationary, as the slightest noise or movement will cause the timid creature instantly to disappear, so acute are they in sight or hearing, or perhaps in both; and they seldom reappear when once frightened.

"By remaining perfectly quiet, however, when the animal is paddling about, it is possible to obtain an excellent view of its movements on the water; it seldom remains longer than one or two minutes playing on the surface, but dives, and reappears a short distance above or below the place at which it was observed to descend.

"Although the animal may 'come up' close to the place where the sportsman is standing, it would be useless to attempt to level the gun, for that action alone would cause its instantaneous disappearance; but, after waiting patiently until the animal dives, and watching the direction in which it sinks, preparation must be made to receive it with the discharge of the piece instantly on its reappearance at the surface, which—when it descends unfrightened—is almost certain to take place in a short time.

"A near shot is requisite, a distant one being almost hopeless; and the aim should be invariably directed at the head, in which part the shots are more likely to take speedy effect than in the loose, dense integuments of the body, which the charge is unable to penetrate. I have seen the skull shattered by the force of the shot, when the integuments covering it have scarcely suffered injury.

"If the water is very clear, the course of the animal beneath its surface after diving can be distinctly seen; but as the places frequented by it usually abound in river-weeds, it is seldom noticed in a clear part of the river. On diving, they never rise again at the same place; but it is not difficult, with a little experience in sporting for these animals to judge with tolerable accuracy where they may come up."

Aquatic as is this animal, it cannot endure a long immersion; and is in the habit of coming ashore at intervals. Dr. Bennett found that if a Duckbill be kept in deep water for a quarter of an hour or twenty minutes, it is so much fatigued that it would soon perish from exhaustion. In consequence of ignorance on this subject, some of the earlier attempts to keep the animal alive proved to be failures. When the Duckbill was taken, its captors placed it in a tub with water, and then were very much surprised to find that by the next morning it was lying drowned if the tub were half full of water; and had scrambled out and escaped if it were full enough to allow the animal to get a foot upon the edge of the vessel.

He also found that the longest time that they

could endure below the surface of the water without requiring to breathe was a little more than seven minutes. Some specimens which he had in captivity, used to sink to the bottom, and lie there quietly, their position being only indicated by a bubble of air rising occasionally to the surface. After a time they would gradually rise in the water, just protruding their nostrils for a few seconds, and again sink to the bottom. Sometimes they float almost entirely immersed, only the part of the beak containing the nostrils being left out of the water. Under these circumstances, the nostrils are often annoyed by floating dust, or other substances; and, if they cannot be cleared off by a sharp ejection of the breath, the bill is carefully washed.

At the base of the beak there is a fold of skin, of which Dr. Bennett writes as follows :—

"The use of the fold or lappet which falls back over the fore part of the head and throat, may be to prevent the mud, into which these creatures thrust their beak, from injuring the surrounding fur; or, what is more probable, protect the eyes from injury during the time that they are burrowing in the earth. The nostrils are situated at the upper surface of the beak, near its extremity.

"The formation of the lips enables the animal to strain the water from its food, which is then conveyed into two rather capacious cheek-pouches. As regards the use of these, Professor Owen observes that any 'air-breathing, warm-blooded animal, which obtains its food by the capture of small aquatic animals while submerged, must derive great advantage from the

structure which enables it to transfer them quickly to a temporary receptacle, whence they may be extracted and masticated whilst the animal is floating on the surface of the water, or at rest in its burrow.'

"These animals have horny teeth on the tongue. On the back part of this organ there is a bulb, which serves to prevent the passage of food collected in the mouth, together with the water, into the gullet, and to direct the former into the temporary receptacles, the cheek pouches, which have an opening on each side, at the back part of the mouth.

"In these I have found the food well comminuted, mingled with fine gravel, of the consistence of mud; the food being composed of débris of insects and small shell-fish, with mud and gravel to aid digestion. I have also found the whole length of the alimentary canal filled with mud or sand, together with fragments of food."

I may here mention that the peculiar shape of the head is obtained by the development of certain bones. The upper jaw is formed from the intermaxillary bones, which are lengthened, flattened, and turned inwards at the ends; while a similar development of the bones of the lower jaw constitutes the lower mandible. In the stuffed and dried specimen, the shape of these bones can easily be traced through the dried skin. When the skeleton is freed from the soft portions, the aspect of the head is even more remarkable than in the living animal, and has quite a grotesque appearance about it.

Dr. Bennett mentions that his Duckbills never looked so absurd as when they yawned. When they

awoke, they generally stretched themselves much as a cat does, thrusting out the fore-paws as far as possible, and spreading the toes, and at the same time opening their jaws to the fullest extent. The action was natural enough; but as one does not expect to see a duck yawn, it was very absurd.

A casual mention has already been made of the fact that the Duckbill can clamber out of a vessel in which it is placed. Unfit as it may seem for performing such feats, the Duckbill is a capital climber—a faculty which is probably needed for ascending the banks out of the water. A pair of young Duckbills which were kept by Dr. Bennett in his house, were perpetually found on the tops of book-cases, or other elevated spots. At last the mode was discovered, and was seen to be exactly the same as that which was formerly employed by chimney-sweepers during their ascent. The animal got between the wall and the furniture, placed its back against the one, and its feet against the other, and so managed to wriggle its way upwards. I may be pardoned for repeating here a personal anecdote, because it illustrates the subject.

During my childhood we were accustomed to get on the roof of a summer-house in exactly the same way. The summer-house was within two feet or so of a stable; and, by setting our feet against the stable wall, and our backs against that of the summer-house, we very speedily reached the roof. This was a useful accomplishment, especially in the autumn, because some remarkably fine Sweetwater and Black Hamburg grapes were trained over the roofs of the

summer-house and stable, and, having a southern exposure, ripened admirably.

The entomological reader will probably recollect that the larva of the tiger-beetle acts in exactly the same manner. When it ascends its perpendicular burrow, it wriggles itself upwards by bending its body, and pressing alternately with its back and belly against the sides of the tunnel. When it wishes to descend, it has only to straighten its body, and down it falls by its own weight.

The animal is not only a good climber, but an accomplished burrower. The fore paws, which are such admirable instruments of propulsion in the water, and aid it so well in climbing, are equally useful when intended to perform the office of a spade. When the animal is on land, the web collapses between the toes, and leaves the claws free to perform their task of digging.

Like many other aquatic animals, the Duckbill lives in burrows which it excavates in the bank. These burrows are often of very great length—seldom less than twenty feet long, and sometimes reaching the great length of fifty feet. They always ascend, so that the water cannot rise far into them; and they have the peculiarity that there are two entrances—one above the surface of the water, and the other below it. The former is generally about a yard or so from the surface of the water, while the other is below it; this secondary passage joining the main burrow a short distance from the other entrance.

Thus the animal can regain its home either by water or by land. If, for example, it has been lying

on the bank, and has completed its toilet as has already been described, it would naturally prefer to walk into its burrow without wetting itself, and being obliged to repeat the operation. But, if it were pursued, or even alarmed, it would dive, and so regain its home unseen.

At the upper extremity of the burrow is the home. This is always oval in form, and much larger than the burrow itself. It is floored with dry weeds and similar substances, and is a very comfortable residence. Within this chamber the animal always sleeps, rolling itself up into a ball like a hedgehog, and uttering little angry growls if disturbed. In it the young ones are born, and pass the first few months of their lives in safety from any foe except man. Even white men, with all their tools, find that to dig out a Duckbill when it has taken refuge in its nest is no easy matter. The natives, however, with no tools better than sharp sticks, can beat the white man in digging, and, when once they have made up their minds to secure the Duckbill, they never fail to do so. The outer entrance to the burrow is almost invariably concealed by grass or other foliage, and is not easily found.

Whether or not the remarkable spur with which the hind foot of the male is armed has any connection with its aquatic habits, is at present unknown, and, indeed, the object of the spur is altogether a mystery. It exists also in an allied animal, the echidna, or porcupine ant-eater, of the same country, and is in both animals thought to be armed with a poisonous fluid.

However, Dr. Bennett, after trying all kinds of experiments on adult male Duckbills, and doing his

best to get himself wounded, could not succeed even in being scratched with the spur. This curious instrument, by the way, almost exactly resembles that of the game-cock, except that it is but loosely attached, and is often kept folded back, so that it is not visible unless specially sought for.

As yet, none of these animals have been brought in a living state to England. They are very delicate in constitution, and, unless supplied with a proper diet, invariably pine away and die. Various attempts have been made, but all in vain. As far as is yet known, molluscs chopped up very fine furnish the best food, but the animal never seems to thrive unless it can forage for itself in the mud. Probably, if some specimens could only be got safely across the sea, they might find sufficient nutriment in the ponds of the Zoological Gardens, but at present the voyage has proved an insuperable obstacle.

The water-repelling property of the fur has already been mentioned. It is a curious fact that this property only exists as long as the animal is in health. This was shown by the various Duckbills which have been captured and kept alive. At first, while they were plump and in good health, the water rolled off their fur as soon as they left it, and they were almost immediately dry; but, when they began to fail in health, the fur failed in proportion, became matted, and would not dry. The mandibles also lost their round plumpness and their beautiful pinky colour.

It is rather interesting to note that even in the Duckbill the sense of humour is to be found. Dr. Bennett states that his pair of young Duckbills were as

playful as kittens, sporting with each other in exactly the same manner, knocking each other over, and pretending to bite. They had even invented a game exactly like our "hide-and-seek," one of them concealing itself and then calling the other to come and look for it.

Although no living specimens have yet been transmitted, many have been preserved in spirits of wine and sent over for dissection. By these means we have attained to some knowledge of the economy of this wonderful creature, which hardly seems to belong to the same epoch as ourselves.

I recollect meeting with a dire disappointment with regard to the anatomy of the Duckbill. At the dissecting room in which I was then working, there arrived a large jar of Australian creatures preserved in spirits. Our exultation was great when among them was discovered the body of a Duckbill. It was held up in triumph, and we were gathering round it in extreme anxiety, when an exclamation of horror and disgust burst from our chief. The ingenious person who placed the Duckbill in the jar had taken the precaution to remove the whole of the interior, and so all our anticipations were frustrated.

However, others have been more fortunate; and, what with the researches of Professor Owen in this country, and the observations of Dr. Bennett in Australia, several of the mysteries relating to this creature have been disclosed. Others yet remain unsolved, involving the distinction, or, perhaps we may say in this case, the relationship, between mammalia and birds. It is to be hoped that these very puzzling difficulties may be soon explained, as, if this be not

done, they will probably remain in their present state of uncertainty. The spread of civilization over Australia has had the same effect upon the Duckbill as it has upon all wild animals, and it is much to be feared that absolute extinction may be expected. Only lately, the curator of a New Zealand museum was obliged to send to England for a preserved Maori's head; and it may be that specimens of the Duckbill may have to be sent to Australia from this country.

CHAPTER X.

Bird Water Trespassers.

Among the birds there is also a graduated series of water trespassers, corresponding in many ways to the mammalia which have just been described.

There are none, however, which correspond with the whale tribe, in living entirely in the water; and this for obvious reasons. The whales are enabled to produce their young in the water; and as the little creatures are born alive and in the full enjoyment of their muscular power, they can swim as soon as they see the light, and can accompany their mothers. The birds, however, lay eggs, which must be hatched by constant and regular warmth. This requisite cannot be supplied in the sea; and, in consequence, the bird is obliged to go on shore for the purpose of depositing and hatching its eggs.

The most aquatic of birds are undoubtedly the Penguins, which pass almost the whole of their time in the water, and seldom come on shore except for breeding purposes. They may therefore be considered as analogous to the seals, which live almost entirely in the water, but sleep on the land, and go ashore to nurture their young.

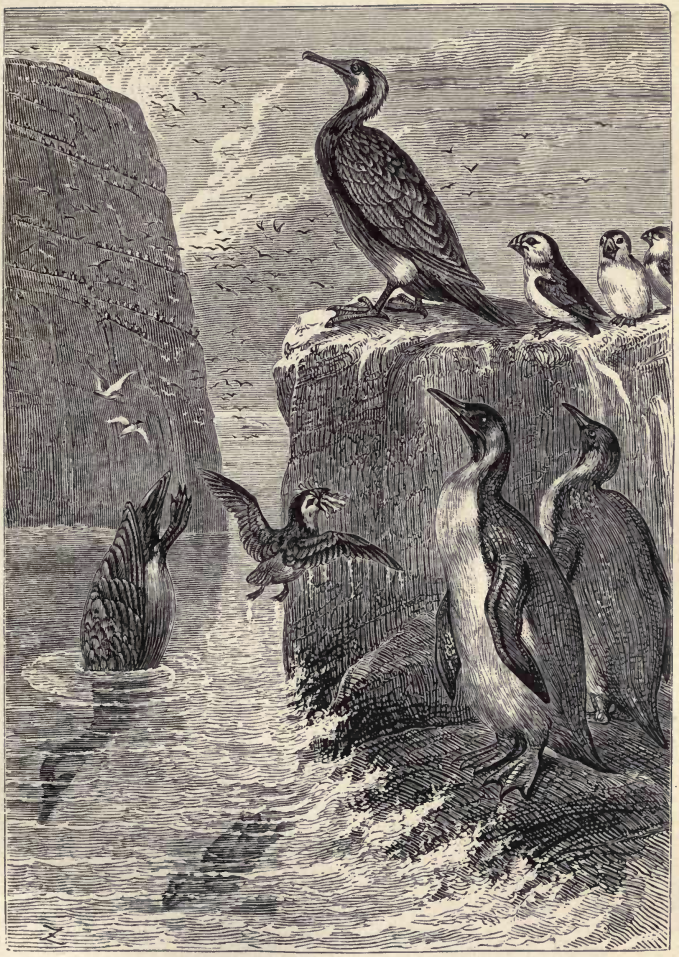
A mere glance at the Penguin will show at once that it belongs more to the water than to the land, and not at all to the air; its structure having been extraordinarily, though simply, modified.

Take, for example, the structure of the bones. In flying birds, they are hollow, very light, and communicate with the lungs; but in the Penguins they are solid, heavy, and have no communication with the lungs.

Then there are the wings, which are absolutely useless for flight. In the first place, they are far too small to support the bird in the air, as may be seen by reference to the figures in Plate IV., where a couple of Penguins are seen standing in the extraordinary attitude which they adopt when at rest. The plumage with which they are covered is not in the least like that of flying birds, but consists of short and very stiff feathers pressed closely together, and looking just like scales.

Although these curiously modified wings cannot be employed to raise the bird in the air, they certainly aid its progress in the water; and in them there is a singular analogy to the same organs in the aquatic ichneumon discovered by Sir J. Lubbock. As this insect will presently be described in full, I shall only refer to it in the present place.

These wings can also be employed for the purpose of running on land, so that for a time the bipedal bird is transformed into a quadruped. Mr. Darwin, when at the Falkland Islands, saw a Jackass Penguin (*Spheniscus demersus*) thus running about among the tussocks on the side of the cliff, and moving



CORMORANT, PUFFIN, AND PENGUIN.

so quickly that it might easily have been taken for a quadruped.

The legs are set as far back as possible, so that when the bird is at rest, it must stand quite erect, as shown in the illustration.

The legs are very short, very powerful, and the feet are broad and webbed, so that when they are put to their proper use, they propel the bird with wonderful velocity. This very structure, however, renders the movements of the bird extremely awkward when it is on shore. The feet have to be crossed over each other at every step, and are brought down with a peculiar slapping noise. This sound, by the way, is produced in perfection by the common cormorant. Several of these birds have been domesticated, and their loud, slapping footsteps were very audible as they went about the house. The albatross also, when trying to walk upon the ship's deck, does just the same thing. We see a somewhat similar mode of progress, though not carried out to such an extent, in the ducks, geese, and swans.

This attitude, and the peculiar shuffling waddle, are utilized by the bird in a very singular manner. Being unable, from its peculiar form, to sit on its eggs in the manner adopted by most birds, it holds the egg firmly between its legs. Then, if disturbed, it shuffles off, carrying the egg with it; and keeping it in its place by the pressure of the short, stiff tail feathers, which are partly bent under it. When hatched, the young is fed by both parents, who are so persevering in their task, that they become quite thin, while the little Penguin grows rapidly into a

downy ball of fat. No bird appears to have any particular nest, but there is a sort of general nest, composed of loose sticks.

Just as the old sailor could never see any use in land except to furnish ships, spars, rigging, and provisions, so the Penguin seems to think that but for the necessity of egg hatching, the land is rather a nuisance than otherwise.

Indeed, Mr. G. Bennett, to whom we are indebted for much of our knowledge respecting these remarkable birds, has met with them at sea, not only out of sight of land, but far from any land known to geographers. Now, when it is remembered that the bird cannot fly an inch, and that all that distance must be traversed by swimming, the natatory powers of the Penguin are very strikingly shown. Indeed, the seal itself is not more at ease in the water than is the Penguin.

The analogy between the marine mammal and bird is further shown by the fact that their food is of a similar character, and obtained in the same way, namely, by fair chase; and it is remarkable that in each case, the trespasser upon the water is superior in speed and agility to the rightful denizens thereof. But, whereas the food of the seal consists mostly of fish, that of the Penguin is found to consist almost entirely of cuttles, the indigestible beaks of which are found in the rapidly digesting stomachs of the birds. I may here remark that similar remains have been found within the fossil skeletons of extinct reptiles of the ancient world, showing that they also fed upon cuttles, and, like the Penguins, could not digest the beaks, nor the scales of sundry fishes which were

found accompanying the cuttle beaks, both being made of very similar material.

In one or two remarkable instances, when Dr. Buckland made those discoveries in geology which scattered terror and mistrust among those who had not sufficient mental capacity to understand their real bearings, even the ink-bag of the cuttle was preserved; and with the ink of a creature that had been dead for more thousands of years than we know, the portrait of its destroyer was taken, and the description of the remains written. So perfect, indeed, was the preservation of the ink, that a professional artist to whom the drawing was shown, asked where such ink could be purchased.

Perhaps the reader may think that the Penguin has an easier task than the seal in procuring food, the former feeding chiefly on molluscs, and the latter on fish. But these same molluscs, called cuttles, or squids, are most active creatures; darting through the water with a rapidity that almost baffles the eye, and having such a tremendous power of impetus, that they have been known to spring completely over a ship. We shall refer to this subject again, when we come to the Air Trespassers. So, if there be any difference in the powers of the two creatures, the bird has rather the advantage over the mammal.

When they do go on shore, the Penguins take no more exercise than they can possibly avoid; and, for the most part, stand motionless in lines so accurately drawn, that any regiment of soldiers might be proud of their dressing.

The most curious part of this proceeding is, how-

ever, the distinctions of rank which are carried out by the birds. Instinctively, they divide themselves into great masses, according to their age, sex, and condition. For example, as Mr. Bennett says, "The young birds are in one situation, the moulting birds in another, the sitting hens in a third, the clean birds in a fourth, etc. And so strictly do birds in similar condition congregate, that should a bird that is moulting intrude itself among those which are clean, it is immediately ejected from among them"

I suppose that after the moult is complete, and the ejected bird takes its place with the full-feathered brigade, none of them would be more zealous in driving out any Penguin that still wanted a few feathers to be completely attired. We all know that a man who has just escaped being blackballed when he desired admission to a club, becomes one of the most uncompromising handlers of the black ball himself, and the strictest scrutinizer into the antecedents of every new candidate for admission.

When the Penguin is in its natural element, the sea, its movements are full of spirit and grace. It feels this contrast so much, that if it be disturbed when on land, it makes its way to the sea through all obstacles. Mr. Darwin gives an interesting account of its behaviour when cut off from its natural element.

"One day, having placed myself between a Jackass Penguin and the water, I was much amused by watching its habits. It was a brave bird, and until reaching the sea, it regularly fought and drove me backwards. Nothing less than heavy blows would have stopped him. Every inch gained he firmly kept, standing

close before me, erect, and determined. When thus opposed, he continually rolled his head from side to side, in a very odd manner, as if the power of vision only lay in the anterior and back part of each eye.

The bird is commonly called the Jackass Penguin, from its habit, while on shore, of throwing its head backwards, and making a loud, strange noise, very like the braying of that animal. When at sea and fishing, it comes to the surface for the purpose of breathing, with such a spring, and dives again so instantaneously, that I defy any one at first sight to be sure that it is not a fish leaping for sport.

Vast multitudes of these birds herd together, and so regular is their arrangement, and so still their attitude, to which allusion has already been made, that they have more than once been mistaken for regiments of disciplined soldiers, drawn up at "attention!"

The extraordinary noise which they make soon dissipates the deception, by means of the ear. Not only do they produce that remarkable sound which has earned for one species the popular title of "jackass," but both parents and child are very noisy when the latter is being fed. Perhaps my readers may have heard the loud, chattering sounds which are produced by starlings under the same circumstances; and if so, they can comprehend what a noise can be made by the Penguin, with its superior power of vocalization. The mother bird always precedes the act of giving the food with a loud clattering sound, which lasts for about a minute; and after the food has been given, makes a similar clatter. Captain Fitzroy, who saw

the Jackass Penguins in great numbers at Noir Island, believes that those birds who are moulting, and cannot therefore procure food for themselves, are fed by their fully-feathered companions, as if they were young and helpless.

AUKS.

Perhaps the bird which comes, or rather, which came, next to the penguin in its aquatic power, is the Great Auk (*Alca impennis*).

This is one of the species which has become extinct by the agency of man within the present generation, just as did the Philip Island parrot of Australia (*Nestor productus*) after it, and the dodo some years before it. This extinction of species is one of the most curious problems of zoology, especially when it takes effect on such birds as the magnificent cockatoo, called the Philip Island parrot, and the great auk. It can easily be understood how a large, fat-bodied, slow-paced bird like the dodo should be rapidly extirpated, especially as it was unable to fly, and the flesh was very good to eat. Moreover, the bird was a local one, and its extirpation was accomplished by sailors, the least accustomed of all men to weigh the future consequences of present acts.

But the case is different with the other two birds. Take, for example, the Philip Island parrot. Fifteen years ago, whilst describing this bird, I mentioned that "it may probably become extinct at no distant period, as its singularly shaped beak renders it an

object of attraction to those who get their living by supplying the dealers with this and other objects of natural history; and its disposition is so gentle and docile, that it readily accommodates itself to captivity." The bird is now, as far as is known, extinct, and I have reason to believe that the last specimen perished even before these sentences were printed.

Still more extraordinary is the disappearance of the Great Auk. Both the previously mentioned birds were essentially local, the dodo inhabiting the Mauritius and neighbouring isles, and the Philip Island parrot being confined to the spot whence it takes its name—a mere islet only some five miles in extent. Then the former bird was eminently sluggish, and the latter neither very active nor wary.

But in the case of the Great Auk, the case is widely different. It had a very wide range in Northern regions, and was found in Labrador, Norway, Iceland, Greenland, Spitzbergen, and even on the northern coast of Scotland. Moreover, it was a singularly active bird, scarcely less swift and agile than the penguin, which it much resembled in general form. Like that bird, it did not possess wings suitable for flight, those members being reduced to a very small size, and only useful as fins in the water. The feathers are longer than those of the penguin, but the wing is absolutely useless for aërial progress in both birds.

The specific name, "impennis," or wingless, alludes to the very small size of the wing, though it is not a really correct term.

Yet, in spite of its wide range and its extreme activity in the water, it became extinct with a rapidity

that is absolutely startling. Within the memory of middle-aged men, the bird was considered as a common one, and in 1813 great numbers of them were killed and eaten, having been captured at a place called the Auk-Skar, in consequence of the multitudes of Auks which used to breed upon it. One of these birds was taken alive at St. Kilda in 1822.

One day—it was really almost as circumscribed a time—ornithologists woke up to the knowledge that the Great Auk had disappeared from the face of the earth. The sharpest watch was set in every place which the bird had been known to visit, and expeditions of skilled ornithologists scoured sea and land in hopes of lighting upon the bird. All was in vain, and the only remains of this once plentiful bird are to be found in thirty-four skins and forty-two eggs, not more than were taken in one day at the Auk-Skar in 1813. The birds were well known in the Orkneys as the king and queen of the auks, but, as far as we know, the living bird will never again receive a name from anyone.

As is the case with most of the Auk tribe, the eggs were laid on rocky shelves, or similar spots, and were inaccessible to ordinary foes. None but the stout-hearted cragsman, with his trusty rope, could descend from the top of the cliff to the resting-place of the Great Auk, or ascend from a boat.

Like the marine birds in general, it was accustomed to seek its food among the fishes, and those who knew its habits said that it fed chiefly upon the common Lump-fish (*Cyclopterus lumpus*). It also lived upon various crustacea and similar creatures. It fed its

young after the manner of the penguins, and the young bird was accustomed to depend on its parents for food long after it had attained its full growth.

The most familiar of these birds is the Little Auk, commonly called the Puffin (*Fratercula arctica*), so well known for its enormous and brightly coloured beak, the orange stripes of which are retained long after death, although their brilliancy is much dulled.

In this bird the wings are well developed, so that it is able to carry its prey out of the sea and bring it ashore to its nest, which is usually made towards the summit of a cliff. The Puffin breeds in burrows, which it excavates for itself if it cannot find a deserted habitation of a rabbit, or cause one to be deserted by turning the owner out, a nefarious feat which it has been known to perform. Being a small bird, and its wings not very large, it cannot carry large fish through the air, but contents itself with little fish somewhere about as large as an ordinary sprat. It has a curious way of catching them all by the head, and arranging them in a row along the side of its beak, so that the look of the bird as it rises from the water is not a little grotesque. In the centre of Plate IV., the lower figure shows the bird diving in chase of its finny prey, and the upper as rising and carrying the sprats in its bill, as has just been described.

The reader will probably have noticed how closely the Puffin follows the habits of many aquatic mammalia, finding its food in the water, and its home in a burrow, which it digs in the bank. The labourers say that the bird makes wonderfully deep galleries,

and that persons who are walking near the edge of the cliff can hear the Puffins uttering their peculiar grunting cry beneath their feet.

While engaged in digging, they are so intent upon their work that they can be taken by hand. Generally, however, the Puffin resents vastly any intrusion into its domicile, biting fiercely with the sharp-edged beak, from which the bird has derived the popular name of coulter-neb—*i.e.*, with a beak resembling the coulter of a plough.

GREAT NORTHERN DIVER (*Colymbus glacialis*).

Another of our water trespassers among the birds is the Great Northern Diver. This bird is seldom seen on the coast of England, being, as its name implies, a northern species.

It is nearly as aquatic in its habits as the penguin, and, like that bird, spends much more of its time in the sea than on shore. As may be inferred from its popular name, it is a great adept at diving, being able to swim for a considerable distance under water, and to endure a submersion of more than three minutes without needing to breathe. It is said to be able to swim at the rate of some seven or eight miles an hour, and this is likely to be the case, as the swiftest boat can scarcely approach near enough for a shot. I may here mention that the generic name, "Colymbus," is of Greek origin, and signifies a diver.

It obtains most of its food from the sea, but, as is the case with many marine birds, is sometimes driven

to the shore, where it has to put up with frogs, insects, and such "small deer," in lieu of the fishy diet to which it is accustomed. Stormy weather generally forces the Diver into such straits for subsistence.

Not that it is afraid of the water, for even in the roughest weather it may be seen sporting amid the waves with perfect confidence. But in stormy weather the fish descend to such depths that the Diver cannot catch them, especially as the darker surface of the waves prevents the light from penetrating much below the surface. Every swimmer is aware that whereas on a calm day he can, when diving, see objects in the water almost as plainly as if they were on land, even a breath of wind that is sufficient to create a ripple on the surface will cause a comparative darkness.

Near Oxford there is a well-known "lasher"—*i.e.*, an artificial cataract—that serves to carry off the superfluous water above a lock. This lasher-pool was always a much-frequented bathing-place, and one of the feats to which we were accustomed was to jump into the middle of the lasher, and be hurled along in the boiling torrent until we came out in the smoother water below. All who have done this have noticed the regular transition from darkness to light. At first the water is so dark that nothing can be seen, the light being kept out by the thick foam on the surface; but it rapidly improves in lightness, and when the smooth water is gained, the eyes can be used with perfect ease. So, in the case of the Diver, the bird is not daunted by the waves, but it is prevented from seeing the fish at the depths to which they then descend.

So familiar are they with the water, that they sleep on its surface as safely as if they were on land, their heads tucked comfortably in their shoulders, after the manner of birds. Generally, a Diver descends below the water by means of a sudden leap, and, if it be pursued, comes to the surface and dives again with such rapidity that the best marksman will hardly have time for his aim. But it can also compress its body sufficiently to allow itself to sink gradually, and if it should take alarm and not see immediate danger, it will then submerge itself until only its head remains above the water.

The legs being short, and set very far back, the bird has much of the attributes of the penguin when on land, sitting bolt upright, and being almost as bad a walker. Indeed, its gait hardly deserves the name of a walk, but can only be called an awkward shuffle. The long, lithe, and powerful neck enables its sharp and powerful bill to be used with terrible effect among the fishes, and to defend itself against foes, at whom it strikes quickly and fiercely, as the heron does.

How efficient a weapon is this beak may be imagined from the fact that within one of these birds were found nineteen flounders and a salmon-trout. It is no matter of surprise, therefore, that so voracious a creature should be in great straits for food when it is obliged to depend on frogs and insects for subsistence.

THE CORMORANT (*Graculus carbo*).

On Plate IV. may be seen two figures of the Cormorant. One is represented on the upper part of the plate sitting on a rock and looking after the young, while the other is diving into the water for the purpose of catching fish. The skill of the bird in this act is quite proverbial; and, just as the cheetah has been trained to capture antelopes on the ground, and the falcon to chase birds in the air, for the use of man, so has the Cormorant been trained to chase and capture fish, not for its own use, but for the services of its master.

As the nest of the Cormorant is always, if possible, placed on some elevated spot, it is evident that the wings of the bird must be developed sufficiently to enable it to rise in the air though impeded by the weight of its prey. Accordingly, we find that the wings are large and powerful, but that they can be folded to the body so closely that they offer no resistance to the water, and allow the bird to assume that nearly fish-like form which is so noticeable in many diving birds. This form is well expressed in the bird which is represented plunging into the water.

THE GANNET (*Sula bassanea*).

I mention the Gannet, not only for its skill in the water, but for a most remarkable modification of its structure by which it is able to obtain its prey from the water.

It can dive to some depth and for some distance, as is proved by the fact that it is sometimes caught in the fishermen's nets, having been entangled in them when chasing its prey. But it does not catch fish like the birds which have already been mentioned. Their usual plan is to swim about on the surface of the water, then to dive, and, if they are successful, to come to the surface, swallow their prey, and dive again.

The Gannet, on the other hand, takes its prey much after the fashion of the common kingfisher. It hovers over the sea at some height, watching for fish. When it sees a chance, it darts down into the water with wonderful force, and almost invariably comes up with the fish in its mouth. The osprey catches fish in a somewhat similar manner, except that it does not dive beneath the surface, and catches the prey with its claws, and not with its beak.

It is evident, therefore, that the hawk does not strike the water with such force as does the Gannet, and, indeed, keeps itself, by its outspread wings, from being dragged below the surface by the weight of the fish which it has taken in its claws. But the Gannet hurls itself into the water with such force that it would injure itself by the shock, were it not protected in some manner from the collision with the water. This object is attained in the following simple and effective manner:—

I have already mentioned that the bones of flying birds are hollow, and communicate with the lungs. In the Gannet there is a further development of the idea. Not only are the bones hollow, but the skin is hollow also, if I may use such an expression. It is perforated

with a number of cells or sacs, varying greatly in size. These sacs communicate with the lungs, and are filled with air, this fact being evident at every respiration which the bird makes. The reader will now see that these air-sacs form an elastic cushion between the body of the bird and the water, so that when it makes its violent plunge, the shock is a very trifling one.

Moreover, this remarkable structure serves other purposes. These cells, when fully inflated, contain about one hundred and eighty cubic inches of air, and therefore render the bird so buoyant, that it can float securely on the roughest sea. Unlike the cormorants and divers, which swim very low in the water, the gannet floats on the surface like a cork.

Then it also acts as a protection against cold, and enables the bird to remain at sea during weather so inclement, that all other birds are driven to seek the land for shelter. There are few instances in the animal kingdom where a single and so simple a modification of structures should serve three such important and yet diverse purposes as a spring-cushion, a life-buoy, and a blanket.

THE GREBES.

There is a well-known tribe of aquatic birds called the Grebes, of which we possess several indigenous species, the best known and most common being the Little Grebe, or Dabchick (*Podiceps minor*), a bird which is represented on Cut 10.

They may at once be known by the peculiar form

of the feet, which are webbed like those of most aquatic birds, except that the web of each toe is separate, giving to the whole foot the appearance of a "palmated" leaf with three lobes. These birds have many of the habits which belong to the penguins, except that they have fairly powerful wings, and can fly for long distances. As their legs are short and set very far back, and their bodies and necks are long, they are very bad walkers, having much of the shuffling gait which has already been noticed in the penguin and other sea birds. Indeed, the Grebes do not trouble the land much with their presence, and, except when engaged in sitting on their eggs, pass nearly the whole of their time in the water.

Several other species of Grebe inhabit these islands, such as the Great Crested Grebe (*Podiceps cristatus*), and the Eared Grebe (*Podiceps auritus*), either of these popular names being equally appropriate to each bird, the ears deserving the name of a crest, and the double crest that of ears.

As to the Dabchick, it is a queer little bird, with an oddly contradictory way about it. It is at the same time one of the shyest and boldest of birds. It fears the presence of man, and yet frequents his neighbourhood in a way that few bolder birds would copy. I have often noticed, when travelling by railway, that in the little ponds which are so often found on the edge of the line, there are two aquatic birds—namely, the Water Hen and the Dabchick, neither of them being in the least disturbed by the swiftly-rushing train, with all its accompaniments of shriek, roar, rattle and thunder.

CUT 10.—WATERHEN AND DABCHICK.

It is perfectly easy to watch the habits of the birds. The ponds which they frequent are generally fringed with reeds, rushes, and other vegetation. Supposing any one to walk casually in the direction of one of these ponds, he might be absolutely unaware of the presence of the Dabchick. On seeing him, or even on hearing his footstep, the bird would sink itself in the water, only keeping its beak above the surface, and merging its outline so well among the weeds and their shadows, that the sharpest eye can hardly see it.

So perfect is the concealment, that even if the intruder be an entomologist, and engaged in the capture of aquatic insects, he may be working away with his net for an hour or two, and yet be unsuspecting of the Dabchick's presence.

Some years ago, I was greatly struck with this capability. As all Oxonians know, there is in the centre of the great quadrangle of Christchurch, popularly called "Tom Quad," in honour of the domed campanile in which the bell, "Great Tom," resides, a circular pond. This pond generally goes by the name of "Mercury," because in olden times there was a figure of that deity in the centre. I never saw him, though my recollections of Tom Quad are of some forty years' date, because the undergraduates bathed him so often, that he was at last removed altogether.

Now, this pond, which was originally the basin of the fountain of which Mercury formed the centre, is constructed of stone, and has no shelter whatever around it. Some years ago several Dabchicks were

placed in this pond, so that every opportunity was offered for studying their habits.

After a while, they became used to the presence of man, but for a considerable time they retained their natural wariness. Whenever any one approached the basin, the little birds would dive instantaneously, as if they had some sheltered spot to which they could retreat. Shelter, however, there was none, and the water was so clear that they could be seen throughout the whole of their proceedings. As there was no aquatic vegetation in which they could hide, the Dabchicks always made for the shaded side of the basin, and, under cover of the shade, used to rise very gradually to the surface. They would only just allow their heads to be seen above the water, and as they kept themselves closely against the dark side of the basin, they would escape the observation of any one who was not specially looking for them. Indeed, so well were they concealed, that I have often found some difficulty in pointing out the birds, though, the basin being but a small one, they were only a few yards distant.

Still, if any one should wish to watch the Dabchicks in their wild state, he can generally do so by approaching very quietly the pond which they frequent, and sitting absolutely still. For a time he may not see a single bird, but after a while the Dabchicks appear to become accustomed to the motionless object which at first alarmed them, and they generally make their appearance and swim about as merrily as if a human being were not within a mile of them.

It is noticeable, by the way, that neither birds nor

wild animals appear to fear human beings when they are absolutely still. To lift the hand, or even to turn the head, will frighten them at once; but as long as a man sits, or even stands still, the wild animals seem to have no fear of him. For this reason, the scarecrows that are stuck up in gardens and fields are really not of the least use, for there is no bird so stupid as to be deceived by them for a single minute. If the scarecrow could be made so as to move its arms in the wind, it might do service in frightening the birds, but as it is generally made, a stump of a tree would be of quite as much use.

The rapidity with which these pretty little birds dive is very remarkable, especially when their movements are quickened by alarm. But even when they are diving for food or amusement, they are wonderfully quick. They pop below the surface so rapidly that the eye can scarcely follow them, and all that can be seen is, that where the Dabchick was a moment ago, nothing is left but a little circle of ripples. Then, when they again reappear, they do so almost as suddenly as they vanished, popping up to the surface like cork, and nodding their heads in an absurdly self-satisfied manner. Should it see anything which alarms it, the little bird is no sooner up than it is down again, and it will not for some time afterwards show itself openly.

When alarmed on land, the Dabchick, in common with most aquatic birds, prefers the water to the air by way of refuge. In consequence of its wonderful powers of diving, it has been called doucker, or ducker. As the legs are placed very far back, the

Dabchick is a bad walker on land, shuffling along with a very awkward gait, although it can get over the ground with some little speed.

It is usually to be found in fresh waters, but during the winter time it is driven to the sea and the mouths of tidal rivers for subsistence. This habit has caused it to be considered by many persons as a migratory bird, and, indeed, it may be held as a partially migratory one, only that its migrations do not extend beyond the limits of the country.

The general habits of all the species of Grebe are very similar, and, as the Dabchick is the most familiar, I have taken it as the type of the genus. I may mention that in some parts of England, any Grebe is called by the popular name of loon, a title which by rights belongs to the Great Northern Diver.

DIPPER (*Hydrobates cinclus*).

The birds which have been previously mentioned all belong to one great group of aquatic birds, which can at once be recognized as such by their form and plumage. The webbed feet, for example, would alone be a definite proof that the bird is meant for the water more than the land. But we will now glance at two more water trespassers, one of which belongs to the thrushes, and the other to the rails, neither of them having the aquatic form, the peculiar plumage, nor the webbed feet.

The first of these is the Dipper, our only representative of the ant-thrushes which are so conspicuous in

other countries, and some of which are so gorgeously coloured. Our species does not possess the splendid plumage, but is yet a pretty bird, with its dark-brown back and white and chestnut breast. It is to be found in most parts of England, but, on account of its solitary and retiring habits, is not so often seen as might be supposed by reason of its frequency.

It has more than one popular name, being in some places called by the appropriate title of the water ouzel, in consequence of its relationship to the thrush family; and in others by the less appropriate name of the water crow.

The word "dipper" very well expresses the movements of the bird. It could hardly be called a diver, because diving infers the power of swimming through the water, while the Dipper possesses this power in a very limited degree, and, as far as is known, only uses it to descend to the bed of the stream.

The generic name of *Hydrobates* refers to the same characteristic. It is composed of two Greek words, and literally signifies "water-walker." As for the specific name, *cinclus*, it is by no means appropriate, for it signifies vibration, and was, in all probability, applied by Aristotle and other Greek writers to the wagtail.

The ordinary manner in which the Dipper enters the water is by walking into it, clinging with its large feet to the stones or other objects in the bed of the stream, and searching on all sides for its prey. It does not remain under water for any long time, but comes to the surface, swims to the shore, and is ready for another dip. Sometimes it picks up the caddis-

worms, and as it is not able to pull their tough cases to pieces while in the water, it takes them ashore, and there extracts the fat white grub from its dwelling-place. It is worthy of notice, by the way, that the length and development of the feet, which do the bird such service in the water, render its gait on land a peculiarly awkward one.

Objections have been raised to the peculiar movements of the Dipper while under water, and many persons have doubted whether it really does walk on the bottom of the stream. Their chief argument—and it is certainly a strong one—is, that the natural buoyancy of the body would cause the bird to rise to the surface, so that the action of walking must be impossible. To this argument, however, it was replied, that as the bird had been repeatedly seen walking under water, no amount of opposite theory could alter a fact. Moreover, the action of the Dipper was not that of the same bird when walking on land, for in the former case the bird clings to the bed of the river, and by so doing is able to force its way against the stream.

Another argument might also be used, which I believe has not as yet been brought forward. In the "Annals of Sporting" there is a passage which seems to me to afford a key to the problem. An observer was watching the proceedings of five Dippers, probably the parents and their three children.

"They next entered the water and disappeared, but they did not all do this at the same time, neither did they do it in the same manner. Three of them plunged overhead instantaneously, but the remaining

two walked gradually into the water, and, having displayed their wings, spread them upon the surface, and by these means appeared entirely to support themselves.

"In this position they continued for some time, at one moment spinning themselves, as it were, two or three times round, and at another desisting, and remaining perfectly motionless upon the surface; at length, they almost insensibly sank."

This last sentence is an extremely valuable one, especially as the writer had no idea that he was elucidating one of the problems of natural history. It is evident that this bird, like those which have already been described, has the power of contracting its body at will, so as to make itself heavier than the water. This being the case, the Dipper would have no difficulty in walking under water, the supposed buoyancy, on which so much stress was laid, not existing at the time, and only resumed when the bird wishes to return to the surface.

The food of this bird is almost wholly composed of aquatic insects, molluscs, etc., though it will occasionally eat small fish. It has already been mentioned that in searching for prey, the Dipper makes its way up the stream. The reason for this proceeding is evident. Did the bird walk down the stream, it would not see the various insects that are carried towards it by the force of the water. Moreover, whenever it turned over a stone in search of prey, the hidden insect would be swept away from it; while, as the bird keeps its head up the stream, the prey is carried into its mouth. Within the stomachs of those Dippers

that have been dissected, the remains of aquatic insects are always found, chiefly consisting of the head, wing-cases, and legs of various species of water beetles.

WATER HEN, OR MOOR HEN (*Gallinula chloropus*).

If the reader will refer to the illustration in which the dabchicks are represented, he will see that near them is a Water Hen engaged in looking after her eggs. She may well do so, for her nest is singularly conspicuous and very large, and the eggs are usually some seven or eight in number, and of considerable size. It is always placed near the water, as the bird, being a really aquatic one, always takes to the water instinctively when alarmed. Indeed, when it is only just hatched, and looking like a shapeless ball of black down, out of which a head oddly protrudes itself, it is much more at ease in the water than on shore, and swims and dives as well as its parents.

At a little distance, the Water Hen seems to be rather a plain bird in point of plumage, just as the splendidly attired magpie appears to be only black and white; but when closely examined, the adult male is found to be one of our handsomest English birds. In its nuptial plumage, which is in the beginning of spring, the general colour is rich dark olive-green, looking a brighter hue on the sides. The head and neck are deep purple, and the legs are bright green, with a crimson bar just above the knee, looking exactly as if the bird wore green silk stockings and crimson garters.

There is also a patch of bright scarlet on the base of the yellow bill, the scarlet portion extending over the forehead, and looking singularly beautiful as the bird swims to and fro, nodding its head in its own peculiar manner. If the weather be calm, the scarlet patch is reflected in the water, and has a most curious effect, seeming to rise from the depths as the bird bends its head downwards, and then sink again as it raises its head. A similar effect is produced by the white patch on the beak of the common coot, as I have often seen when watching the birds as they swam on the lake at Walton Hall. Mr. Waterton never would allow a bird to be molested, and, in consequence, even these birds, which are generally wild and shy, allowed themselves to be approached closely without showing the least alarm.

The Water Hen is quite as good at concealing itself as is the dabchick, and is full of artifice. I once detected one of these birds in a very ingenious ruse. I was with a friend in a boat on the Isis, near Sandford, when a Water Hen that was sitting on the bank took alarm, and flew into the water with the usual impetuosity of these birds. It dived as soon as it struck the water, and made as though it were intending to cross to the other side of the river. Not caring particularly about the bird, I happened to be looking towards the bank from which it had plunged. Presently the artful bird came to the surface under the shadow of the weeds that overhung the bank, and quietly stole off between them and the bank itself. It had doubled when under water, thinking that it had induced us to fancy that it was crossing to the opposite side, and that we should

never dream of looking for it on the bank which it had quitted so precipitously.

I once employed the same ruse very successfully. There was a game very popular at Oxford. We used to jump into the river, and try to catch each other under water—a sort of aquatic "prisoners' base," and with some of the same rules. There was one very good swimmer of whom I was rather afraid, as he immediately followed me. It must be remembered that to catch your predecessor is easier than to avoid being caught by your successor. You can see the man whom you are chasing, but you do not know what your pursuer is doing, or how near he may be. So, as soon as I entered the water, I gave a strong curl and twist of the body, so as to bring me under the bank, where I held on to the lowest step of the bathing-ladder. My pursuer consequently jumped over me, and while he made a momentary pause, and was looking for me ahead, found himself unexpectedly seized by the ankle. Unfortunately, that is a trick which cannot be played twice.

The Water Hen has another method of concealing itself, which is even superior to the art of the dabchick. When it is really anxious about its safety, and dives, it swims to some place where there is a patch of weeds or aquatic vegetation, and rises very slowly, with its head stretched upwards. It does not allow even its head to appear above the surface, but only shows the beak as far as the nostrils. Bishop Stanley says that when these rather combative birds fight, the vanquished one acknowledges his defeat by diving and not appearing again. He merely keeps his beak above the

water for the purpose of respiration until he has recovered, and then makes off.

How well it can dive is evident from the fact that one of these birds was caught in a net with which a river was being dragged, and another was taken upon a hook by Mr. Morris, who mentions that they have been found upon night-lines set for fish. The first of these birds was apparently dead, its feet clinging with the death-grip to the meshes. It was relieved with much difficulty, and laid on the ground, when it was found that life was not extinct, but that the bird was too weak to be able to stand. In the hope that it might recover, it was placed among the flags on the river bank, when it immediately sprang to its feet and ran off into shelter, as if nothing had happened to it. Similar examples of simulated death in the Water Hen have been noticed by many observers.

CHAPTER XI.

Insect Water Trespassers.

As every one knows, who has paid the least attention to practical Natural History, there are very many insects which can almost invariably be found in the water, and very seldom elsewhere. Such, for example, are to be found in the great groups of water beetles, water boatmen, water gnats, water scorpions, etc., etc. Now as all insects breathe atmospheric air, it is evident that any insect which is found in the water must be a trespasser, and therefore entitled to a notice in this book. These insects are, however, so numerous, that I can only select one of each kind as an example of the entire group.

Any one who has looked into a pond, or the still parts of a stream, must have noticed the vast number of beetles that inhabit the water; some spinning in mazy circles on the surface, and seldom going below it; while others, with long oar-like legs, are perpetually coming up from the depths below, and diving down again out of sight. The general structure of all these latter beetles is in all important points the same, and so we will take one species as a representative of them.

GREAT WATER BEETLE (*Dyticus marginalis*).

It is impossible to point to a more perfect example of design than this creature, which is made for two elements only, namely, water and air, and is quite helpless when on land. The whole of the insect is covered with a very hard shelly skin, composed of the horny substance called "chitine," which is, I believe, peculiar to the insect tribes. The surface of the insect has such a polish, and is so hard, that to hold one of these beetles in a living state is not at all an easy matter; and even when they are dead and dry, they are very apt to slip through the fingers. They are absolutely impervious to water, which has no hold on their surface; and, if the beetle be captured, as it comes up after a dive, it will be found that not a drop of water has adhered to its polished surface.

The wing-cases, or elytra, as they are technically named, are very large, somewhat convex, and come well over the sides, to which they cling so tightly, that no water can penetrate the junction. Under the elytra are the ample and powerful wings, which, in spite of their size, are packed so closely as to leave space for the curious structure which enables the insect to remain under water for a considerable time.

The reader is probably aware that insects have no lungs, and do not breathe through nostrils as do the higher animals; but that their whole body is permeated with air tubes opening into certain apertures along the sides, called spiracles.

It is evident, therefore, that the body of the insect

must be very light in proportion to its bulk, and must have a very strong tendency to float. Accordingly, any one who watches these insects will see that they cannot keep themselves below the surface without continuous exertion; and that as soon as they cease from action, they rapidly float upwards. This buoyancy has a use to which reference will presently be made.

The question now presents itself, how the supply of air is to be renewed below the surface of the water. This is done in exactly the way to which reference was made during the description of the whales—namely, by carrying a supply of air below the water. This supply is kept in the space between the wing-cases and the body; and as the spiracles open into it, the insect can take with it a supply of air that is sufficient to last it for some time.

Of course, the beetle is obliged to act just as the whales and seals do, *i.e.*, come to the surface at intervals for breath, and this it can do with great rapidity. If alarmed, it just rises to the surface with its tail upwards, protruding the ends of the elytra for a moment, ejects the air that has been used, and takes in a fresh supply. This is done with such speed, that the rising to the surface and the subsequent descent seem to be one and the same action.

Perhaps the reader may have noticed when looking at a still pool, that bubbles of air are almost continually rising to the surface. The large bubbles, which appear at rare intervals, are almost entirely due to the gases caused by decomposing matter at the bottom of the pool. But the very small bubbles, which are scarcely perceptible, except when watched for, are mostly caused by the respiration of aquatic insects. The air traverses

the whole of the body, and then, after having done its work, is ejected in a series of tiny bubbles. So that when these bubbles are seen, they will form an indication to the observer of the wealth of animal life that exists below the surface.

Owing to the great buoyancy of the Water Beetle, it is obliged, if it wishes to remain below the surface, either to continue the action of diving or to cling to some object which will prevent it from being floated upwards. The males are furnished with a remarkable apparatus for this purpose. Three joints of the fore legs are very much flattened and rounded, and are covered on their under surface with a great number of circular suckers, which act exactly like those of the cuttle-fish. These suckers cling so firmly, that, as I have seen myself, they retain their hold long after the death of the owner, and may be seen sticking to the stones of the pond after the beetle itself has putrefied and floated off.

When the Water Beetle is not alarmed or engaged in the chase of prey, it is fond of floating at the surface of the water with its head downwards, its swimming legs stretched out at right angles to the body, and the tips of its elytra just projecting in the air. It is not easy to see the insect in this attitude, because it is exceedingly wary, takes alarm at the least movement, and dives below. On a fine summer's day, it affords rather an amusing sight to steal up very gently to a pond, and take up a place where the wate can be observed closely. In doing this, the chief precaution is to avoid throwing the shadow on the water; for so readily do these creatures take alarm

that even the shadow of a passing bird or butterfly will send them below.

If the approach has been properly made, the surface of the water will be seen to be thickly studded with these beetles, all lying motionless, and apparently enjoying the warm sunbeams. The multitude of these insects which will find room in a small pond must be seen to be believed. A casual passenger will scarcely know that there is a single beetle in the pond, for his approach will have sent them all below, the only aquatic insects visible being the whirlwigs and the water gnats, who seem to be incapable of fear, and traverse the surface of the water as freely as if no intruder were near.

There is a little pond near my house which admirably illustrates the habits of these insects. On a fine day, the whole surface is covered thickly with these creatures, scarcely any of them descending, but others ascending in all parts of the pond, and immediately floating motionless at the top. Then, if the spectator but raises an arm, all is flurry and confusion, and the water is filled with the rapidly descending insects. A few moments more, and except the whirlwigs and water gnats, there is not a sign of life in the pond.

The Water Beetles, of which the Great Water Beetle is a type, are very numerous, and vary greatly in size; some measuring a full inch in length, while others are scarcely the eighth of an inch long.

They are all predacious creatures, finding their food chiefly among the larvæ of the various water insects. They are not at all fastidious as to the peculiar food which they eat; and have no hesitation in

attacking and devouring their own kind. It is in consequence of this voracity that they are furnished with such powerful wings; for when they have exhausted the supply of food in one pond they can easily fly to another.

THE WATER BOATMAN (*Notonecta glauca*).

There is another large group of water trespassing insects, which are popularly and appropriately called Water Boatmen, and equally appropriately, though not, perhaps, as intelligibly, by the scientific title of Notonectidæ. This term will presently be explained. They belong to the order called Heteroptera; and, although they agree in many points with the water beetles, they are very diverse in others.

Both groups of insects pass the greater part of their time in the water, find their food in the water, prey upon living beings, and are exceedingly voracious. Both, also, are furnished with wings, by means of which they can transport themselves from one piece of water to another. But they feed in a different manner and swim in a different manner.

First, as to the feeding. The water beetles seize their prey in their jaws, and tear it to pieces; the mandibles being strong enough to pierce the human skin and draw blood. The Water Boatman, however, goes on a different principle. It has not jaws like those of the water beetle; but the parts of the mouth which in an insect are numerous and complicated, are modified into a short, but very sharp proboscis. When

the Water Boatman is hungry, it goes in search of some unfortunate insect; and having overtaken it, clasps it in its fore legs, and draws it tightly against its head, by the same action driving the proboscis into it. The juices are then sucked, and when they are exhausted, the Water Boatman throws off its now useless prey, and goes off in search of another.

I have often watched these Water Boatmen employed in capturing and killing the water gnats which may be seen traversing the surface of any still river or pond. The water gnat is active, but seems to be powerless against the Water Boatman, which rises from below, clasps the unfortunate insect, and almost before the eye can detect its movements, has the proboscis buried in its body.

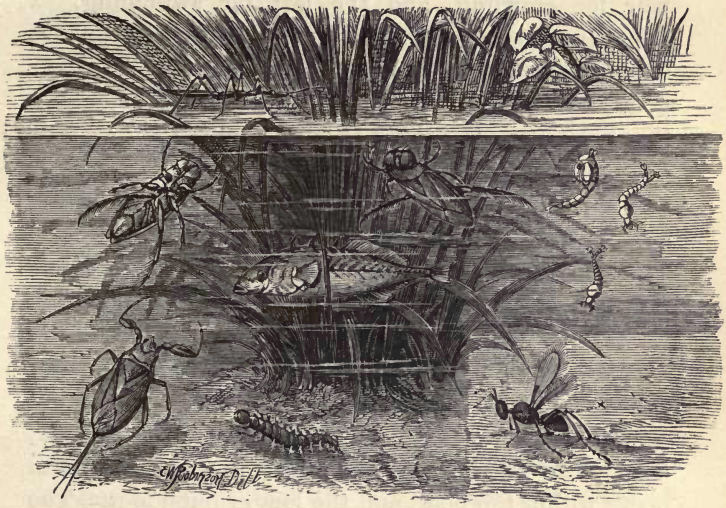
The time occupied in sucking an insect varies considerably. I have often watched the process, and have found that, whereas in some cases five minutes is enough for a water gnat to be sucked dry, in another case the operation lasts for a full quarter of an hour. I apprehend that the difference of time is caused by the greater or less hunger of the captor.

Although the Water Boatman is not a large insect, the proboscis is strong and sharp enough to inflict a severe prick upon the human hand. I fancy that in some species, at all events, some kind of a poisonous fluid must be injected into the wound. There is one of these insects belonging to the genus Corixa, which is as large as the present species, but wider and flatter. I have more than once been pricked by the proboscis of the Corixa, and have always found that the sharp smart of the prick was followed by a dull aching pain,

which very much resembled that which generally follows the sting of a wasp after the first pang has gone off.

Now for a few words as to the special aquatic capacities of the creature.

In the first place, it has the curious habit of swimming on its back. If it be taken out of the water



CUT. XI.—WATER BOATMAN, WATER SCORPION, SWIMMING ICHNEUMON LARVA OF GNAT, AND WHIRLWIG

and examined, it will be found that the wing-cases are so formed, that, when closed, they present a most curious resemblance to the keel of a boat. This is not the case with all Water Boatmen, for in some, such as the Corixa, which has just been mentioned, the back is flat. But even in these cases the boat-like form is

very perceptible, and the difference between the two forms is just that of the keeled rowing-boat and the keel-less canoe.

Another very remarkable point is the structure of the rowing legs, or oars, as they may be called. The last pair of legs are reserved for this purpose, the first pair being chiefly used for catching prey, the middle pair for crawling, and the last for swimming. I strongly recommend the reader to capture one of these insects, which may be found by hundreds in every pond, and to examine the structure of their swimming legs. I cannot but think that they gave the first idea of oars, as used at the present day, *i.e.*, propelling instruments set at right angles to the central line of the boat, having broad ends and a very powerful leverage. The superior power of the oar over the paddle is the reason why the latter has been gradually abandoned in favour of the former.

Now, in the leg of the Water Boatman all the elements of the oar are found.

Firstly, there is the leverage. An oar is a lever, the fulcrum of which is the rowlock, the shorter arm being within the boat, and the longer outside it. The shorter arm being pulled by the rower's hands, causes the longer to describe a considerable arc in the water, and the end of the oar being flat and thin, so as to offer the greatest possible resistance with the least weight, the boat is urged onwards.

Now, let us take the Water Boatman, and see how the rowing legs of this insect comply in every respect with the boat-oar which has been slowly developed through a series of years. In the case of the insect,

the fulcrum, instead of being a rowlock affixed to the side of the boat, is formed by the horny shell of the insect's side. The short lever is represented by that part of the limb which passes through the shell into the interior of the thorax, and the stout muscles of the thorax, which are fixed to the leg, take not only the office, but the exact position of the arms of a human boatman.

Next, we come to a small but important point. All of my readers who have been trained to the use of a boat, and to

"Feather their oars with skill and dexterity,"

must remember how much trouble they had to take in order to turn the oar at the end of the stroke, so as to present the edge, and not the flat side of the blade, to the air, as the oar is drawn back for another stroke. It is one of these things which looks absurdly easy, but in which the very ease betrays the consummate skill of him who handles the implement.

In the rowing legs of the Water Boatman we find a provision for feathering exactly like that of the human boatman, except that the rowing limb, as made by nature, is infinitely superior to the oar which is formed by art. Supposing that a boat-builder could invent an oar in which the blade should be very much longer, wider, twice as strong, and not half as heavy as the blade of a wooden oar, and that as soon as the stroke was made the blade vanished altogether, leaving nothing but a thin, tapering spike of wood, a tremendous advantage would be given to the boat's crew which first made use of the improved implement,

and the speed of rowing would be very much increased.

This is exactly what is done by the Water Boatman, and I strongly recommend the reader to catch a few specimens, put them in a glass vessel of water, and watch the action of the rowing legs. The blade of the oar in the insect is found in a fringe of very stiff hairs, with a slight curve backwards. The joints of the leg are so constituted, that the limb has only one set of movements, which are almost exactly like those of a human rower, and the effect is very remarkable.

As the stroke is made by which the Water Boatman is propelled, the bristly fringes are expanded, so as to "catch" the water, in the language of oarsmen, while their slight curve enables them to "hold" it to the end of the stroke. No sooner is the stroke over, than the leg gives a slight turn in the socket, and, as the limb is thrown forward preparatory to another stroke, the bristly blade collapses, the sharp edge of the leg is turned towards the water, and so the insect is enabled to send its legs forward with the slightest possible friction against the water.

Only one point more with regard to those natural oars. My rowing readers will remember that the grease-pot is part of the essential furniture of a boat, and that the leather and "button" of the oar have to be frequently lubricated. There are few things which worry an oarsman so much, or which impedes his progress more, than the want of grease. In the first place, the friction is increased very greatly, entailing much needless exertion; and in the next place, the squeaking sound of each stroke is nearly as irri-

tating to the senses as that of a slate pencil when held by an awkward child.

Now, the natural oar of the insect has its grease-pot as well as the artificial oar of the human being. The joints, especially the principal one at the thorax, are lubricated with a natural grease exactly analogous to the "synovia," or oily fluid, which diminishes the friction in the joints of human beings. It is worthy of notice, too, that in artificial machinery man has to imitate the absolutely perfect machinery of nature. I have always thought, when looking at a steam-engine at work, and seeing the oil-cups above each important part, that the engineer was only executing a clumsy imitation of nature, and that the greatest engineer of coming times would be a man who was versed in the anatomy of the human frame.

The air which serves the purpose of respiration while it is beneath the surface, is carried between the wing-cases and the body, exactly as has been narrated of the water beetle. Fortunately for observers of nature, the wing-cases are sufficiently translucent to enable the progress of the air to be seen through them. I believe that I was the first to describe this progress, through actual observation of some Water Boatmen that I kept in an aquarium.

The discovery was quite a matter of accident. I had been keeping some Water Boatmen in a bottle which was standing on my desk, and happened to get one of the insects between the eye and the light. The translucent character of the elytra at once was evident, and the course taken by the air was perfectly visible.

In order to obtain a supply of air, the insect rises to the surface of the water, protrudes the end of its tail, and takes in the required supply. By degrees the air-bubble which then appears under the elytra is pushed gradually forward, and, when it has done its duty, escapes in a series of very tiny bubbles at the spot where the bases of the elytra are pressed against the breast.

THE WATER SCORPION (*Nepa cinerea*).

In the lower corner of the same illustration may be seen the very remarkable insect called the Water Scorpion. This name is given to it in consequence of the peculiar outline of the creature, which certainly does bear some resemblance to that of the scorpion. I well recollect how startled I was, when, as a boy, I first found this insect. I was watching the inhabitants of a certain fish-pond at Radley, when I saw an object that I had taken for a piece of dead leaf begin to move about. In those days there were no books to give information on such subjects, and the scorpion-like claws and the sting-like projections of the tail, rather deterred me from touching it. However, it was so curious an insect, that I got it out of the water with a stick, and very soon found that it could do no harm whatever.

It does not possess the activity of the predacious insects which have already been mentioned, and trusts to craft rather than speed for procuring its food. I have no doubt that the insects on which the Water Scorpion feeds are deceived, just as I was, by its

resemblance to a dead leaf. When any luckless insect comes within reach, the two fore legs are struck smartly at it, and almost to a certainty the prey is inclosed in the limb, the joints of which fold closely upon one another. Then, the prey having been seized, it is firmly held while the beak of the captor is driven into its body, and its juices sucked, as has already been narrated of the water boatman.

The manner in which the Water Scorpion obtains air for respiration is worthy of notice. On referring to the illustration, the reader will see that there is a dangerous-looking spike projecting from the tail. This is a compound instrument, forming a sort of channel, along which air can be introduced to the respiratory system while the body is under water. For this reason the Water Scorpion is generally found close to the bank, so that it can be protected from foes by its wonderful resemblance to a dead leaf, and, while resting in the mud, protrude its spiky tail above the surface, and so take in the needful air.

I may here mention, that there is an allied insect that has, as far as I know, no popular name, but is scientifically called *Ranatra linearis*. One of these insects was taken by a young lady of my acquaintance, and she, not knowing its name, called it "Daddy," from its resemblance to a Daddy-long-legs fly without the wings.

She kept the insect in a glass globe, and "Daddy" soon became quite an important personage in the house. He used to catch prey with a wonderfully sharp stroke of the fore legs. Various aquatic larvæ and insects are its usual food, and I have seen it prey

upon the fresh-water shrimps, in spite of their shelly armour.

The insect used to crawl very gently and quietly towards its prey, and as soon as it came within reach, would raise its fore legs well over its head, and deliver a blow so rapid that the eye could hardly follow it. "Daddy" was of a very combative nature, and would strike at anything which annoyed it. Irritating the insect with a pencil was rather a favourite amusement, and certainly, the courage of "Daddy," and the force of the blows which he delivered on the pencil, were well worthy of notice. Like the preceding insects, the Ranatra is furnished with large wings, which are packed with great neatness beneath the elytra.

THE WHIRLWIG BEETLE (*Gyrinus natator*).

We will now pass to a few examples where insects are trespassers upon, rather than beneath, the water.

The reader will recollect that mention has been made of the Whirlwig Beetles, so called from their perpetual gyrations upon the surface of the water.

These curious insects look exactly as if they were encased in burnished steel and then oiled, so hard, polished, and slippery are they. The modification of structure which enables the insect to whirl about in so active a manner is well worth investigation.

The two fore legs are rather long and slender, and are used, like those of the preceding insect, in capturing prey. The middle and last pairs are exceed-

ingly short, wide, and flattened into a paddle-like form, by means of which the insect can take those short and quick strokes which propel it so swiftly over the surface of the water, and enable it to turn with such agility. When the insect is taken out of the water, these paddle-legs are tucked under the body, so that it only appears to have two legs—*i.e.*, the first pair, which project in front of the head.

It may be easily imagined that an insect whose legs are thus modified does not make much progress on land. Its attempts at walking are almost as awkward as those of the sloth, for all the crawling that it can do is managed by the two fore legs, the other two pairs only moving the body by a series of jerky hitches.

On the water, however, it skims over the surface with consummate ease, forming graceful curves, like those of a practised skater, and gliding about with an equally apparent absence of effort. This perpetual movement is necessary to enable the Whirlwig to take its prey, which consists mostly of the tiny insects that fall upon the water and cannot immediately free themselves. It is a very sociable insect, a solitary specimen being rarely seen, and the Whirlwigs appear to take as much pleasure in their sociable swim as do the gnats in the perpetual rising and falling of their airy dance.

It has been said that in their gyrations they are so active that they never strike against each other. This is by no means the case. I have repeatedly seen collisions take place, but without the least damage to either party, the hard and polished armour of their bodies effectually protecting them.

As if to carry out the curious similitudes in art and nature which have been indicated when mentioning the resemblance of the water boatman to a keeled, and the water beetle to a keel-less boat, the Whirlwig bears an equally striking resemblance to the Welsh coracle, its swimming legs also resembling paddles instead of oars.

The wings of the Whirlwig are large, and the insect can use them with wonderful readiness, by jumping out of the water by a violent jerk of the four swimming legs, and instantly taking to wing. So quickly is this done, that although the Whirlwigs are continually darting into the air, they escape detection, being mistaken for ordinary flies. The water boatman, by the way, can perform a similar feat, and when it takes to wing, it produces a loud, deep, humming sound like that of the hornet. It has quite a startling effect if the insect should happen to pass close to the ear.

The peculiar eyes of the Whirlwig have often been described. Generally, the compound eyes of the insects are restricted to two clusters; but in the Whirlwig they are again divided, so as to form four clusters. Two of these occupy the usual position, and are above the surface of the water when the insect swims. The other pair are set almost on the underside of the head, and are, in consequence, always submerged.

Perhaps we may understand the position of the eyes better by an illustration. The profile of the Whirlwig's head bears a close resemblance to that of a fish—say a perch. If we then suppose that the

upper cluster of compound eyes occupies the same position as the eyes of the fish, the lower clusters will be placed at the angles of the lower jaw, just at their junction with the upper jaw. Thus the insect is specially fitted for its water-trespassing life, by possessing one set of eyes for the water and a second for the air.

At the bottom of the illustration, and occupying the middle, is seen a creature which has some resemblance to a centipede. This is the larva of the Whirlwig, and the projections from the side are the gills or branchiæ, as they are scientifically termed. This larva is always in motion, so as to make the water impinge against the gills. Generally, it does so by means of a graceful serpentine curve, in which the white gills stream about like white plumes waving in the wind. Sometimes it will wriggle its way upwards for several inches, and then sink to the bottom, the gills being stretched out on either side of the body, and helping to support it.

These larvæ are much eaten by the water scorpion, who finds plenty of nourishment in their fat, soft bodies.

THE WATER GNAT (*Gerris lacustris*).

Again I take a single species as a type of several others—the insect which is represented as walking on the surface of the water. There are many insects belonging to the Heteroptera, which are grouped together under the general and appropriate name of Hydrometridæ, or Water Measurers. They all have slight

bodies and very long legs, and in some, such as *Hydrometra stagnorum*, both the body and legs are so exceedingly delicate, that the insect looks almost like a shadow flitting over the surface of the water. Take half an inch of a fine needle, support it on four black hairs, and stretch out two hairs in front of the head, stain the needle black, and there is a very fair imitation of the Hydrometra.

Slight and delicate as is this creature, it is a very predacious one, and I have seen them seizing and carrying off their prey quite as ferociously as "Daddy" used to do. The Hydrometra feeds almost entirely upon the small insects that fall into the water. It comes gliding up to them like a shadow, and almost as silently, picks up its prey with the very ends of its fore legs, and, holding the captured insect out at the full stretch of its legs, makes for the shore, where it sucks the juices, and then goes off in search of more prey.

It is worthy of remark, that the process of sucking seems to have no effect whatever upon the outward aspect of the victim. I have seen plenty of water gnats killed and sucked by the water boatman, and when the exhausted prey is rejected, the keenest eye cannot detect any change of form. It could at once be "set" and dried, and in that case would look as well as if it had been killed by poison or boiling water.

THE SWIMMING ICHNEUMON FLY (*Polynema natans*).

In the lower corner of the same illustration may be seen a square space marked off, so as to separate it from the rest of the figures. In it are two winged insects—one moderately large, and the other very small. These are representations of the Swimming Ichneumon, the smaller figure giving it of its real size, and the larger showing it as it appears when magnified.

As we have already seen, there are plenty of swimming insects. These, however, all propel themselves by means of their legs, which are modified for that purpose, and their wings are kept closely hidden under the elytra. In the Swimming Ichneumon, however, we have a most remarkable anomaly in the history of insects. The ichneumons belong to the Hymenoptera—*i.e.*, the order which contains the bees, wasps, ants, etc.; and that one of these creatures should swim, using its wings instead of fins, appears to be an anomaly. Yet this is just what the Swimming Ichneumon does, and its discovery forms an epoch in the history of entomology.

As the reader will see from the account which will presently be given, the insect was discovered almost simultaneously by two individuals within a week, but as one of them, Sir J. Lubbock, Bart., had the precedence by a few days, the discovery belongs to him.

Similar examples of nearly simultaneous discovery

are familiar to all students of science. One such instance occurred to myself. I had settled a doubtful point in the anatomy of insects by dissection of the humble bee. According to custom, the description of dissection was written in full, and entered in the book. Some six months afterwards, the same discovery was made in France, and published. But as, in all matters of science, the individual who publishes the discovery first has the credit of it, this particular one belonged to France, and not to England.

The following account of the discovery of the Swimming Ichneumon was read before the Linnæan Society on May 7, 1863, and afterwards printed in the "Transactions" of that Society.

"On one of the early days in August, I was enjoying myself by watching the animals in a basin of pond water.

"It is customary to regard the inhabitants of fresh water as less beautiful and varied than those of the sea. But though our inland lakes and rivers can boast no sea anemones, no starfishes, medusæ, shrimps, nor sea urchins, they still are full of beauty and variety.

"Without counting the rarer forms, almost every weedy pool contains specimens of daphnia, cyclops, diaptomus, and asellus among crustacea, the hydra among polypes, the lovely green volvox, and many other algæ, besides numerous desmidiæ and diatomaceæ, with insects almost innumerable. Besides the perfect insects, such as water beetles, notonecta, nepa, and other hemiptera, there are larvæ of dragon flies, beetles, phryganeas, and ephemeras, the beautifully

transparent larvæ of corethra, and many other species of diptera. But though most of the great orders are more or less richly represented, no aquatic species of hymenoptera or orthoptera had, till now, been discovered.

"The female of Agriotypus armatus, indeed, has been observed to descend the sides of rocks in the Clyde to a considerable depth, and to remain there several minutes. Even this species, however, cannot be considered as truly aquatic, or as being entirely at home in the water, since there is no evidence that it knows how to swim. Mr. Smith also reminds me that Smiera (Chalcis) femorata and S. sispes are said to be parasites on the aquatic larvæ of Stratiomys, in which case the perfect insect probably seeks its prey under water; but I am not aware that it has been actually observed to do so.

"The species of Hymenoptera have been estimated at about 30,000 in number, and Mr. F. Smith (than whom there is no better authority) informs me that about 12,000 have been already described, 3,500 of which live in Great Britain. From the interest attaching in many cases to their habits, from their marvellous instincts, and their curious relations to other animals (no order presenting more parasites and victims of parasites), the peculiarities of Hymenoptera have received more attention than those of almost any other group of invertebrata.

"Great, therefore, was my astonishment, on the occasion to which I allude, when I saw in the water a small hymenopterous insect, evidently quite at its ease, and actually swimming by means of its wings. At

first I could hardly believe my eyes; but having found several specimens and shown them to some of my friends, there can be no doubt about the fact. Moreover, the same insect was again observed, within a week, by another entomologist, Mr. Duchess, of Stepney. This gentleman mentioned it to Dr. Sclater, and from his description and sketch, there can be no doubt that the insect observed by him belongs to the same species.

"It is a very curious coincidence that, after remaining so long unnoticed, this little insect should thus be found, almost simultaneously, by two independent observers. Perhaps this may, in part, at least, be accounted for by supposing that the insect was unusually abundant this summer. Yet Mr. Duchess appears to have met with only one specimen. Mine were altogether twenty-one in number, and the females were more than twice as numerous as the males.

"As the motion in Polynema natans is caused by the wings, it might almost be called a flight; owing, however, to the density of the medium, and partly, perhaps, to the direction in which the wings act, the movement, though not inelegant, is slow, and is rather a succession of jerks than a continuous progression.

"The insect is provided with tracheæ, and respiration appears to take place through spiracles in the usual manner. Most of those insect larvæ which spend much of their time under water are either provided with gills, or carry down with them a supply of air attached to their body, and from which the tracheæ can be replenished. Our insect possesses neither of

these advantages; nor can much respiration take place through the skin, which is thick and chitinous.

"Moreover, it has some difficulty in passing from air to water, or vice versa: a bubble of air would quite destroy its equilibrium when under water, and a drop of water would equally prevent free motion in the air. The difficulty is, however, mitigated by the fact that the air in the tracheæ requires changing only at considerable intervals. A common house fly placed under water ceased to move in half an hour. My specimens, however, of Polynema natans lived under water several hours without suffering any apparent inconvenience. One, which I put in a bottle full of water at 7 o'clock in the morning, was quite lively at 7 o'clock in the evening, after having therefore been no less than twelve hours at least under water. I say at least, because I had no means of knowing how long it had been there before my experiment began. Probably, however, this was about the limit of its endurance; for four other specimens which I treated in the same manner at about 6 o'clock in the evening, were apparently dead at the same hour on the following morning; and the individual above-mentioned was itself motionless at 9 o'clock, or after fourteen hours of submersion. I then, however, put it in a dry bottle, and next morning it was as lively as ever. Wishing to see whether it retained any unpleasant recollections of its drowning, I gave it the opportunity of again entering the water, which it immediately proceeded to do.

"I was unfortunately unable to ascertain whether they could fly: taking my opportunity when they

were out of the water, I teased several specimens of Polynema natans with the point of a needle; but never succeeded in making one take to its wings—at least, not in air. When walking on the water, however, they sometimes started off suddenly; but always kept close to the surface, so that it rather seemed as if they were carried by some tiny gust of air."

Sir John Lubbock then proceeds to remark that the insect has no peculiarity which indicates an aquatic life, such as we see in the boat-like form and the oar or paddle-like legs of the insects. No one would therefore think, in case of seeing a Swimming Ichneumon in the open air, that it had habits differing so greatly from those of its kinsfolk in general. "Permit me to say, in conclusion, that if *Polynema natans* and *Prestwichia aquatica* had been extinct species, no palæontologist would have suspected that they were aquatic. In the present state of our knowledge there is nothing in their structure which would have suggested such an idea."

The wings are made after a curious fashion, but certainly have no aquatic look about them. The upper pair are about as long as the body, and are flat, covered with hairs, and edged with a deep fringe of bristles. No nervures are perceptible, even with the aid of a magnifying glass, if we may except a slight thickening on one of the edges. The second, or lower pair of wings, could scarcely be taken for wings if removed and viewed independently of the insect. When the insect is at rest, these wings are crossed over the back, and the hairs with which they are edged make a radiating fringe round the whole of the abdomen.

The generic name, Polynema, refers to this peculiarity. It is formed from two Greek words, the former of which signifies "many," and the latter, a thread or filament. Some of these hairs or bristles are even longer than the breadth of the wing. There is a closely-allied species, *Mymar pulchellus*, in which these hairs or bristles are more than twice as long as the wing is wide.

The writer also calls attention to the very imperfect state of our entomological knowledge. The order of the Hymenoptera is one of the most popular and best studied in all entomology, inasmuch as in it we have the best workers, and most interesting species that are as yet known to the world. The bees, wasps, and ants are proverbial for their industry and the wonderful structures which they erect; while the Ichneumons are equally interesting on account of their parasitic habits. Yet, here is an indigenous Ichneumon which escaped observers for many years, and at last was only found, as it were, by chance.

Another point which is to be considered, is the object for which the Polynema enters the water. The obvious reply to such a query is, that it does so for the purpose of meeting with subaquatic insects in which to deposit its eggs. There are, however, two objections to the theory, either of which seems fatal; the first being, that the male enters the water as freely as the female; and the second, that the larvæ of all known Hymenoptera breathe atmospheric air, and could not exist beneath the water.

THE GNAT.

There are many more insects which are water trespassers, but our space warns us to be brief. We will therefore be content with two examples of insects which are water trespassers in their larval states; but which, when they have attained their perfect condition, would soon die if they fell into the water and could not extricate themselves.

Perhaps the best-known, and certainly the most plentiful of these insects, is the common Gnat (*Culex pipiens*), so well known from the beautiful plumy antennæ of the male, and the venomous proboscis of the female. With the perfect insect we have nothing to do, it being a denizen of the air and not of water; and we are at present only concerned with it in its earliest forms.

It begins its water trespassing career while it is still in the egg form; and I cannot but think that this is the most curious of its three, or perhaps four, different modes of trespassing, each of which will be very briefly described.

The egg itself very much resembles a skittle in form; and, if placed in water, would sink and never be hatched, for want of warmth and air. Yet it must be placed in the water, because the larva when hatched, finds its food in the water, and on land is absolutely helpless; so that if it were hatched ashore, it could never make its way to the water.

The solution of this rather difficult problem is

another of the many instances in which nature has anticipated art. A single plate of iron will sink, but a number of plates, if arranged in a definite form, so as to cause the weight of their united bulk to be less than that of a corresponding bulk of water, will float. The iron ships, and iron caissons, and iron docks of the present day, are familiar examples of this fact.

Now, the eggs of the Gnat are arranged on exactly the same principle. They are placed side by side, and glued to each other with a fluid secreted by the mother insect, and which is not soluble in water. Taught by instinct, the Gnat, without even seeing the eggs, builds them up into a boat-like form, and then leaves the little vessel to float on the water. And, as every practical entomologist knows, the egg-boat is built on exactly the same principle as the best life-boats of the present day, righting itself if it be upset by force. Any number of these boats may be obtained from the surface of a pond, or even a water-butt; and they make very interesting objects for the magnifying glass.

After a short space of time—varying according to the warmth of the weather—the larvæ are hatched, and are liberated from the egg by means of a little lid which opens at the end, and allows them to drop into the water. In this form they are probably familiar to all who have used their eyes. There must be few people, indeed, who have not seen in rain-water these curious little larvæ, looking, with their large heads and slender bodies, something like the conventional dolphins of ancient art. They swim by a series of

waggling movements, bending themselves almost double, and then suddenly straightening the body.

Although they live in the water, and find their food there, they cannot breathe in it as can those larvæ which respire by means of gills, and are obliged to have access to atmospheric air, just as are the aquatic insects which have been described. This is done after a curious manner. The breathing-tubes with which the whole body is permeated open into two large tubes, which run along the sides. These tubes pass into the tail, and the orifice is surrounded with a star-like fringe of radiating hairs. When the larva wishes to breathe, it ascends to the surface, and, head downwards, just protrudes the tip of the tail above the surface, where it is upheld by the hairy fringe.

The process of breathing may be easily examined by taking a little glass tube, such as is used by homœopathic chemists, heating it in a spirit lamp or a gas flame, and squeezing it until it is nearly flat. If, then, it be nearly filled with water, and a Gnat larva placed in it, the creature can be examined with a tolerably high power of the magnifying glass. Unless the tube be flattened, the lens cannot be brought near enough to allow of a sufficiently high power to be used.

After a while, the larvæ assume the pupal state. There is not very much difference in their appearance or their actions. Their shape remains much the same, except that the part which comprises the head and thorax of the future insect, is now very large, seeing that it contains the long legs and wings. It still

respires atmospheric air, but does so in a different manner. Instead of obtaining air through the tail, it breathes through some little tubes which are placed in the thorax. The body is much curved, and the creature, although it can move about, has not its former activity, and is unable to eat.

The large size of the pupal skin is the last feature in the water trespassing habits of the Gnat, as without it the perfect insect would never be able to free itself from the water. As it is, when the Gnat is fully developed it rises to the surface, and then, with a powerful movement, splits the skin throughout a considerable portion of its extent. The split skin opens out, and forms a sort of boat, which is very buoyant. The Gnat slowly draws itself out of the skin, and, standing upon its cast garment, moves its wings in the air until they are dry and firm, and then takes flight.

THE RAT-TAILED FLY, OR DRONE FLY (*Eristalis tenax*).

Here we have another of the numberless examples in which a slight and simple modification of form enables a creature which breathes atmospheric air to exist while under water.

We are all familiar with the common Drone fly, which is so plentiful in the summer time, and which looks so very much like a bee. In its perfect state it is a denizen of air, darting along with such velocity that the eye can scarcely follow it. But in its preliminary stages it is a dweller in the water, or rather

in the mud, and perfectly motionless, as we shall presently see.

These larvæ are not at all pretty objects, looking in miniature very much like brown soda-water bottles, with necks some four feet long. As in the gnat larva, that of the Drone fly breathes through the tail, and a very curious tail it is. The gnat larva being able to swim through the water, and ascend to the surface whenever it desires, has nothing abnormal in the shape or size of the body, the chief peculiarity being the star-like fringe by which the orifice of the breathing tubes is kept in contact with the air.

The larva of the Drone fly, however, passes a very curious existence. It lives in soft mud, mostly that which is obtained by the decomposition of leaves in the shallow water at the edge of a pond. Into this very unfragrant material it burrows with its head downwards, and there remains until its larval life is over. The problem now remains, how it is to obtain a supply of air. This is done by means of the extraordinary appendage which has gained for it the popular title of "rat-tailed" maggot.

The end of the body is modified into a tube, which can be lengthened or shortened at the will of the owner, and through this tube run the air-vessels which supply the body. When all is quiet, the larva elongates the tube, so that the tip of it projects just above the surface of the water, and it is thus enabled to breathe, just as the elephant does when it walks across the bed of a stream, and only keeps the tip of its trunk above the water.

Here, again, we find that art has been anticipated

by nature. At the present day we are able to execute subaquatic works of great magnitude — such, for example, as the Dover piers—by means of the diving apparatus. This is nothing more than an imitation of the Rat-tailed larva's air-tube, the diver being submerged for hours at a time, and supplied with air through an elastic tube.

Should anything occur which might alarm the insect, the tail is instantly and swiftly withdrawn, so that scarcely a trace of its presence is left. I once found quite a preserve of these larvæ in a neglected water-butt which was nearly filled with dead leaves, dead insects, and other *debris*. They were so thickly planted in the fetid mud, that their tails looked just like a number of fine grasses set closely together. It was curious to see the effect of a tap on the edge of the barrel. In a moment every tail was withdrawn, and the few inches of water that was left above the mud became on a sudden quite clear and bright.

The best way of observing the remarkable structure of the telescopic tail, with its double air vessels, is to place one of the grubs with its head downwards in a glass tube, at the bottom of which there is an inch or so of mud. The grub will at once make its way down, and the tube should then be filled with rain-water for some three inches above the mud. The water will soon clear itself, and by means of the magnifying-glass the structure of the tail can easily be made out. With a little management this tube may be so arranged as to bring a moderate power of the microscope—say the half-inch object-glass—to bear upon it.

It is interesting to draw off the water gradually, and see how the grub instinctively shortens the tail, the peculiar elasticity of the air-tubes, with their wire-like coils of filaments, keeping them always open, no matter how much they may be contorted. Then, in order to test the extremest length to which the tube can be stretched, water should be very gently added. As the depth of the water increases, so does the grub stretch out its tail, and the extent to which it can be thus elongated must be seen to be believed.

When this larva is about to change into its pupal state, it wriggles itself out of the water, and crawls upon the ground, in which it buries itself. It then changes into a pupa, and, not needing the tail any longer, respires through four little tubes in the thorax, very similar to those which have been mentioned as belonging to the gnat.

Besides these, there are very many insects, such as the Dragon fly, the May fly, and the Stone fly, which pass their larval state in the water, although the perfect condition is that of a denizen of air, and in no sense may be reckoned as water trespassers. I do not, however, take any detailed notice of these in the present work, because, as long as they remain in the water they are practically water dwellers, and not trespassers, breathing the water by means of gills, and not being dependent for respiration on atmospheric air.

WATER SPIDERS.

Under the present head I rank two members of the Arachnida: one a trespasser in, and the other upon, the water.

The first of these creatures is the Water Spider (*Argyronetra aquatica*), a being which affords another of the many examples in which nature has preceded the art of man. In the rat-tailed fly we have already seen that the diving machinery of modern days has been anticipated by the elongated air-tube of the larva, and in the present case we have an exact analogy with the diving-bell itself. I will first give a brief account of the habits of the Water Spider, and then show the analogy between its habitation and the diving bell.

I must premise, in the first place, that the Water Spider has the power of swimming and diving, and that it obtains its prey in the water. If any ordinary land spider be thrown into water, it will float for a considerable time, being buoyed up by the numerous air-bubbles which are entangled among the hairs of its body. The Water Spider, in addition to this airy envelope, can carry with it a large bubble of air, which is sufficient for its respiration for some little time.

I have often watched the Spider take its bubble beneath the water. It comes to the surface, and waits there for a moment or two, as if to collect its forces. It then gives a sort of jerk of the body and kick of

the legs, and at once dives. If watched, it will be seen to have stretched its last pair of legs well behind the body, and by their aid to have inclosed a large bubble of air, which completely envelopes the abdomen. Burdened—for it is a burden—with this bubble of air, the Spider dives with manifest exertion, and is lost to sight.

Not that when it dives it always takes this air-bubble with it. In fact, as a general rule, it dives without the large bubble, and only has its body studded with the minute bubbles which have already been mentioned. They completely alter the Spider's appearance.

Out of the water the Spider has nothing conspicuous about it, and no one who did not know the creature would ever suspect that it had anything in its mode of life which distinguished it from other spiders. But, as soon as it dives, the multitudinous air-bubbles which surround the body make it look exactly as if it were clothed in an envelope of quicksilver globules, which have a curiously glittering appearance as the Spider descends into the water.

The generic name, *Argyronetra*, refers both to the appearance and the shape of the body. It is compounded of two Greek words, the former signifying silver, and the latter a spindle. This name is given to it in consequence of the form of the body, which ends in a point, and is altogether of a spindle-like shape. If I wished to use strictly scientific language, I should say that the generic name of the Spider was given to it because its body was fusiform; but I prefer to express the same idea in simple English terms.

Many years ago, as a child, I used to watch the Water Spiders diving into the dark, still pools with which the Cherwell abounds, and to wonder where they could be going with their glittering suit of bubbles. As far as I know, when it dives without the large air-bubble, it is either in search of prey or going home. But, when it carries the large bubble within its hind-legs, it is engaged in supplying its subaquatic home with air. Briefly told, this is the story of its home :—

The female Spider, when she is about to lay her eggs, dives to some depth, and searches for a suitable locality among the submerged portions of aquatic vegetation. She then spins an oval cocoon, shaped very much like an empty egg-shell with the end cut off, and having the opening downwards. Having completed this task, she then ascends to the surface, takes down a large bubble of air in the manner that has already been described, and, still laden with it, enters the cocoon. She then releases the bubble, which rises to the top of the cocoon, which is air-tight, and, of course, expels a corresponding quantity of water. Several similar journeys then take place, and in a short time the cocoon is filled with air, and becomes a subaquatic chamber in which the Spider can live.

Perhaps some of my readers may remember the old diving-bells. In the present bells a constant supply of air is kept up by means of pumps and tubes; but in the older bells no such plan was adopted. A quantity of air was forced into strong vessels, which were lowered by ropes to the bell. The divers then took the vessels into the bell, and set the

air free. Thus, there is an exact analogy between the old diving-bell and the home of the Water Spider—the cocoon representing the bell, and the bubble enclosed by the legs taking the place of the air vessels.

Perhaps the reader may ask what may be the real object of this structure, seeing that the Spider can catch its prey in the water, eat it ashore, and hide itself on land like any of its terrestrial brethren? As has already been stated, the cocoon does act as a place of refuge, but its chief object is to serve as a protection for the young. For, singular to state, not only does the mother Spider, herself an air-breathing creature, pass much of her time under the water, but her eggs are hatched and her young are nurtured beneath the water, and never go into the outside air until they are strong enough to shift for themselves. On an average, one hundred little spiders are hatched simultaneously in this subaquatic residence.

When the Spider deposits her eggs, she fastens them to the top of the cocoon, so that they receive the benefit of any air that is contained in it, and then covers them with a circular plate of very tough threads. Similar coverings may be seen on the eggs of many terrestrial spiders, especially those which belong to the genus Agelena.

Some twelve years ago, I mentioned that a gradual but steady destruction of the Spider was taking place, in consequence of the great demand for it as an inhabitant of the fresh-water aquarium. This destruction has gone on so fast, that in many localities where the Water Spider was once plentiful, an absolute extirpation has taken place.

Indeed, so difficult is it at the present day to procure the Water Spider, that I have been unable to give an illustration of the creature and its cocoon. In spite of much search and orders to dealers, not a specimen could be obtained; and, as I did not choose to have an illustration which was not drawn from the actual object, I was forced to omit it altogether.

THE PIRATE SPIDER (*Lycosa piratica*).

There is a very large genus of spiders called Lycosa. This name is derived from a Greek word, signifying a wolf, and is given to these creatures on account of their roving and predatory habits. Popularly, they are called Wolf Spiders, and we have nearly twenty species in England. They are very plentiful, and may be found on almost any piece of ground, especially if it be uncultivated. Being mostly dark-coloured, they escape observation, unless the ground be carefully watched, and then they may be detected as they run with great speed, and pounce upon any stray insect that comes in their way. They spin no web for the capture of insects, though some species line their hiding-places with a silken mantle, and all are in the habit of enveloping their eggs in a silken bag, and carrying it about with them. The celebrated Tarantula is one of the Wolf Spiders.

Among these also we have an aquatic representative which is popularly called the Pirate Spider, because it exercises its depredations on water, and not on land. Like the Water Spider, it has a furry covering, which

entangles air among the hairs, and so enables it to run over the surface of the water. Sometimes it will take advantage of a dead leaf or bundle of weeds floating on the water, and make that extemporized raft its headquarters, sallying out to secure prey, and then returning to the raft on which it can take its meal in peace and quiet.

Although the Pirate Spider can run on the surface of the water without sinking, it can also dive when it is alarmed. Its usual plan of diving is to make use of some water plant, run down its stem, and cling there until it thinks the danger to be past. It can remain below the surface for a considerable time, and, as far as is known, is able to breathe by respiring the air with which its body is surrounded.

CHAPTER XII.

Trespassers upon the Air.

I THINK that we cannot do wrong if we accept the insects as the most perfect types of the denizens of air. How perfect they are in this respect can only be appreciated by dissecting one of the fully-developed insects, and examining its internal anatomy.

I suppose that there are few people who have seen the large-bodied dor beetle, cockchafers, or humble-bees upon the wing, who have not been struck with the ease of their flight, in spite of their large and apparently heavy bodies. This is specially notable in the case of the larger bombylidæ, or humble-bee flies, and the hawk moths, which dash through the air so rapidly that the eye can scarcely follow their movements.

On opening the body, the problem is at once solved. I have already mentioned the system of air vessels with which the whole of an insect is permeated. Along each side, and just under the skin, runs a large tube, into which opens the "spiracles," or little mouths that communicate with the outer air. From these main tubes spring a vast number of smaller

tubes that penetrate every portion of the body, and often cause great trouble to the dissector. They surround and cling to all the internal organs, which they envelope as if in a network of entangling meshes.

Even in the larvæ, which do not fly, this structure is to be found, but it is in the flying insects that it is developed to the highest extent. Not only do these vessels penetrate into every part of the body, even into the delicate antennæ and the membranes of the wings, but they are in many parts of the body swollen into large vesicles, which occupy a considerable amount of space, and materially lighten the body.

One of the most remarkable instances of these vesicles is to be found in the common Stag Beetle.

Considering the enormous size of the head and mandibles in a fully developed male, it would be natural to suppose that even if the insect were able to raise itself in the air at all, it would be overbalanced by the weight of the fore part of the body, and must fly with its head downwards. Yet, not only can the insect fly with its head upwards, but I never saw one fly in any other attitude, and as the Stag Beetle swarms in my neighbourhood, I have had plenty of opportunities of watching its habits.

The large, square head is necessary in order to afford support for the muscles which move the powerful jaws. Here I may parenthetically remark, that it has been said that the male Stag Beetle does not use its jaws for offensive purposes, and cannot be induced to bite. If that be the case, I can only say that it has bitten me without being induced, for I have frequently received very severe pinches from the antler-like jaws.

Take one of these insects, kill it by the "death-bottle," or by dashing it into boiling water, lay open the head and jaws, and a most beautiful structure will present itself. The jaws are then seen to be quite hollow, the hard, horny material being a mere shell enclosing a row of the air vesicles which have already been mentioned. A similar arrangement will be found in the head, so that strength and bulk are beautifully united with lightness. Any of my readers who are students of comparative anatomy will remember that in the elephant these three qualities are combined in a very similar manner, the bulk of the skull being composed of bony, comb-like cells.

The thorax has many of these cells, and in the abdomen they occupy a very large space, especially towards the base of the abdomen, where it joins the thorax. If a large beetle be rendered insensible by chloroform, and the upper part of the head removed, these vesicles can be plainly seen, swelling and lessening with every inspiration and expiration.

We may be justified, therefore, in taking the insects as best representing the denizens of air.

Next to them come the Birds, in which there is a lightness of structure analogous to that of the insects. I have already mentioned that in the flying birds the bones are hollow, and connected by certain apertures with the air of the lungs. In Bennett's "Whaling Voyage," a curious adventure is narrated, which very well illustrates this peculiarity of structure.

"Another bird which we noticed at the same time is a nondescript, but nearest allied to the albatross family. It is the size of the lesser albatross;

its plumage uniformly deep black; its beak and legs white.

"The example we obtained was shot in the wing and brought on board alive, fighting savagely with its beak and feet.

"With a view to preserving its plumage uninjured, I endeavoured to destroy the bird by compressing its windpipe, but found that as the breathing became laborious, a loud whistling sound was emitted from some part of the body, and, upon close investigation, found that the bone (humerus) of the wing, which was fractured across, projected through the skin, and admitted within its tube a forcible current of air whenever the lungs made an effort at respiration.

"The bird was, in fact, breathing through its broken wing; and so sufficient was the supply of air which the lungs received through this novel channel, that I was wearied with my attempts to suffocate my prize, and had to destroy it in another manner.

"The free communication which exists between the air cells of the lungs and the cavities of the bones in birds, offers an easy elucidation of this phenomenon, although such an application of the economy must be regarded as singular."

In connection with this subject, I may remind the reader that the bone of an albatross' wing is much in fashion as a pipe stem, being light, strong, and tubular.

In the Flying Mammalia, this modification of structure is not found, but we shall presently see that in them a similar effect is produced by different means.

CHEIROPTERA, OR BATS.

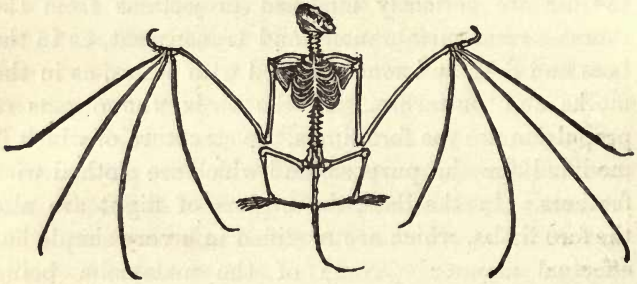
The only members of the mammalia which can really rival the birds or the insects in the air are those remarkable beings which are popularly called Bats, and of which we have several representatives in our own country.

In the insects, the organs of propulsion through the air are variously modified projections from the thorax—some membranous and transparent, as in the bees and flies, and some covered with scales, as in the moths and butterflies. In the birds, the organs of propulsion are the fore limbs, the structure of which is modified for the purpose, and which are clothed with feathers. In the Bats, the organs of flight are also the fore limbs, which are modified in a very simple but effectual manner. None of the mammalia being clothed with feathers, but either having the skin naked, scaled, or hairy, the order of Nature would be infringed if the Bats were gifted were feathered wings like those of birds.

Another mode of flight has therefore to be employed, and this is chiefly done by a modification of the fore feet. In the birds, the fore limbs are not used for progression on land, and consequently the feet are so altered in shape as scarcely to be recognized as such, except by the eye of the comparative anatomist. It is the foot of the bird, for example, which supplies the principal or primary feathers of the wing, the secondaries being attached to that part which cor-

responds with the fore arm of man. Any one can examine this structure by stripping the feathers and skin from the wing of a fowl before it is cooked.

In the Bat, however, the foot, instead of being flattened and crushed into a mere support for the feathers, is developed in a most extraordinary manner, the most being made of every joint. The accompanying figure, will explain this structure at a glance.



SKELETON OF VAMPIRE BAT.

Each portion of the limb is greatly elongated, while the toes are so long and so delicate, that they look as if they had been passed through a wire-drawing machine. The great toe, or thumb, is the only one which is not elongated, and it is furnished with a sharp, curved claw, by means of which the Bat is able to draw itself along a level surface whenever it wishes to walk.

There is another point about the skeleton of the arm, which assists materially in enabling the Bat to

be an air trespasser. In human beings the fore arm is composed of two bones, called the radius and ulna, and by their means the hand is able to rotate and execute the different movements for which it was designed. In the Bat, however, this rotating power is not only needless, but would be absolutely injurious, as it would make the limb incapable of acting as an instrument of flight. The ulna, therefore, is practically absent, being represented only by a very tiny piece of bone pressed against the radius, and, as a consequence, the hand cannot rotate.

The reader will now perceive that there is no necessity for these bones to be hollow like those of the birds, their great attenuation giving them the requisite lightness. No new structure is therefore required in order to convert a mammal into a winged creature, a slight modification of existing structures being amply sufficient for the purpose. A further adaptation is to be seen in the thorax, which is very large in proportion to the animal, and has the upper portion of the breast bone greatly developed, so as to afford an attachment to the powerful muscles which are needed to move the wing.

The next point is to furnish the developed limb with a wide, flat, and light substance that will take the place of the bird's feathers. This is managed in an equally simple manner. In the first place, the toes or fingers are webbed to the tips, like the feet of frogs. This, however, would not afford a sufficient surface, and so the webbing, if it may be so called, extends from the thumb to the neck, and from the fingers to the feet, so that when the limbs are ex-

tended the surface is very large in proportion to the weight of the animal.

There is at least one genus of Bat which possesses still further means of lightening the body.

"In the genus Nycteris a curious faculty is observed, namely, the power of inflating the subcutaneous tissue with air. The skin adheres to the body only at certain points, where it is connected by means of a loose cellular membrane. It is therefore susceptible of being raised from the surface on the back as well as on the under parts. These large spaces are filled with air at the will of the animal, by means of large cheek-pouches, which are pierced at the bottom, and they communicate with the subcutaneous spaces just mentioned.

"When the animal, therefore, wishes to inflate its skin, it inspires, closes the nostrils, and then, contracting the cavity of the chest, the air is forced through the openings in the cheek-pouches under the skin, from whence it is prevented from returning by means of a fine sphincter, with which those openings are furnished, and by large valves on the neck and back.

"By this curious mechanism, the Bat has the power of so completely blowing up the spaces under the skin, as to give the idea, as Geoffrey observes, of a little balloon furnished with wings on head and feet."

The foregoing passage is taken from Mr. Bell's article on the Cheiroptera, in the "Cyclopædia of Anatomy and Physiology."

The reader will remember that some of the sea-birds have the same capacity of inflating a series of

air cells beneath the skin. The various diodon fishes possess a similar power; but in them it is probably used as a means of defence, the swollen body causing the multitudinous spikes with which it is armed to stand out like the prickles of a rolled-up hedgehog.

It has been proved that the wings possess more points of interest than is generally known.

They are almost as elastic as if made of India-rubber, and nearly as delicate as goldbeaters' skin, so that, when the creature is at rest, they fall of their own accord into folds that occupy very little space, and do not interfere with their owner's movements.

They also act as a cradle for the infant young; but one of their principal uses, in addition to that of flight, is their power of directing the course of the Bat as it flies through the air. Anatomists have often been struck with the fact that, according to the usual custom of nocturnal animals, the insect-eating Bats have very small eyes. Taking as examples of darkness-loving and predatory creatures, the owls, the lemurs, and even the domestic cat, we find that the eyes are very large, and we might naturally expect that we should find a similar structure in the Bats. In them, however, the eyes are very small, and there is reason to suppose that they are not much brought into requisition in the capture of flies, moths, and other insects which form the chief food of the Bat.

Many years ago, a series of experiments were instituted by Spallanzani, who had been struck with the fact that Bats could fly with confidence in a

perfectly dark room, and even after they had been blinded. He then stretched threads across the room in various directions, and found that the Bat, blind as it was, never by any chance touched one of them. He then proved that neither smell nor hearing could assist the animal, and therefore concluded that the Bat must possess a sixth sense, at present unknown to us.

Cuvier, however, read these experiments in a somewhat different manner. He looked to the wings themselves for an explanation of this wonderful power of guidance without sight, and found the whole surface of the delicate membrane to be an enormously expanded organ of touch, possessing exquisite sensibility, and being capable of detecting by the sense of touch the presence of external objects. In all probability, therefore, the Bat depends but little, if at all, upon its eyes for the capture of prey, and is guided almost entirely by the sensitive surface of the wings. Perhaps the reader will call to mind the fact that the moles are practically blind, and that when they pursue and capture their prey they are guided by the sensitive snout, which performs the same office for them that the wing does for the Bat.

In our own Bats the external ear is of considerable size, and is formed by a membrane very similar to that of the wing, so that it may probably assist the animal in guiding its flight. The most prominent example of this structure is to be found in our common Long-eared Bat (*Plecotus auritus*), the ears of which are nearly as long as the body, and can be thrown into most graceful curves at the will of the owner.

Other Bats, again, such as our Horseshoe Bat, have membranous growths of a like nature about the nostrils, which, if we may judge from analogy, perform the same office as the membrane of the wings.

THE VAMPIRE BAT (*Vampirus spectrum*).

We will now proceed to examine one or two species of the Bat, taking as opposite types the blood-sucking Vampire and the fruit-eating Kalong. I intentionally put aside our own species, which are all insect-eaters, pursuing their prey through the air in the hours of darkness.

The Vampire Bat is a West Indian animal, and is plentiful about Guiana and the regions of tropical America. It is best known by the blood-sucking habits, from which it derives its popular name of Vampire; but I cannot think that it has no other means of subsistence. Blood-sucking may be a luxury, like champagne-drinking, but I do not think that a Vampire Bat lives on blood any more than a human being on champagne.

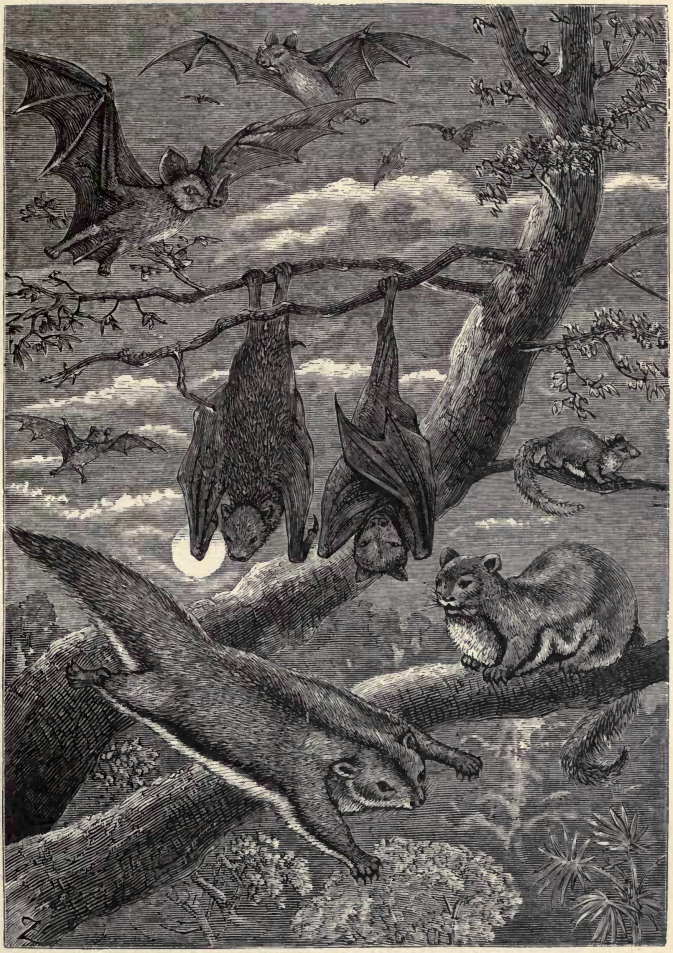
Indeed, if the Vampires had nothing to depend upon but the blood of mammalia, I think that they would soon be in as bad a case as would be the so-called "carrion" crows, if they had nothing to live upon but the flesh of dead animals. As far as can be understood of the animal's habits, it must make its ordinary food of insects, and only drink the blood of other animals when it gets a chance of doing so.

Indeed, I feel sure that, just as there are millions of mosquitoes, fleas, leeches, and similar bloodthirsty creatures, which never taste blood in the whole course of their lives, so it is with the Vampire, whose opportunities of blood-sucking are quite exceptional.

It will, however, seldom neglect a chance which offers itself, and man, horse, or mule are equally sufferers from its predilection for blood. It does not cause much, if any pain, insinuating its needles of teeth into the skin, and quietly drinking the blood as it pours from the tiny apertures.

With animals, the Vampire generally attacks the shoulder or the flank, but with human beings the great toe is the favourite point of assault. The Vampire almost always waits until its intended victim is sleeping, and then draws off the blood so gently and quietly, that the sleeper is not disturbed.

It seems to be rather capricious in its taste. Somewhere about the year 1813, Mr. Waterton, who was then travelling in Guiana, wished to have practical experience of a Vampire's bite. Accordingly, for many months he exposed himself to the attacks of the Vampires, by sleeping in an open shed, through which the bats used to pass freely, and were seen hovering over the traveller's hammock. But not a Vampire would touch him. They bit a native servant who was sleeping within a few yards of his hammock; they bit a young English lad, about twelve years of age; they nearly killed an unfortunate jackass, and they did kill the fowls; but they would not touch Mr. Waterton. Some years ago, when telling me the story, he jokingly remarked, that perhaps the Vampires showed their



VAMPIRE BAT, KALONG, OPOSSUM MOUSE, HEPOONA ROO, AND SUGAR SQUIRREL.

good sense, for there was very little blood to be got out of *him*.

THE KALONG, OR FLYING FOX (*Pteropus rubricollis*).

There are several species of Kalongs, which are spread over a considerable portion of Asia and the neighbouring islands.

On looking at one of these animals, the difference in the eye is at once apparent. As I have already mentioned, the eye is small in the insect-eating bats; but in the Kalong, which is a fruit eater, it is large, round, soft, and full. They are very large when compared with the carnivorous bats, some species having been known to measure five feet across the expanded wings.

Not needing to catch its prey by aërial evolutions, the Kalong has a very different flight from that of the insect-eating bats. As we know, from watching our own species, which are all insect eaters, the flight of the latter is quick and erratic, while that of the former is slow and majestic, like that of some large bird.

They are nocturnal in their habits, though not such utter haters of light as the insect-eating bats. Our own species are scarcely ever seen in the day-time; for as soon as the early rays of the sun show themselves, the bats retire to the dark corners in which they love to assemble. Hollow tree-trunks, disused chimneys, clefts in rocks, and similar localities, are their favourite hiding-places. The Kalongs, on the

contrary, resort to the most open and unprotected spots, such as the highest branches of trees. To these they hang themselves, bat-fashion, with their heads downwards, and their wings wrapped round their bodies.

Whether the bats can or cannot swim, as can most of the mammalia, has long been a disputed point among naturalists, and one which the nocturnal habits of the animals render extremely difficult of determination. It is known, however, that one of these frugivorous bats does possess the power of swimming; and we may therefore infer that other species may be equally able to cope with the water. Nearly in the centre of Plate V. may be seen two Kalongs, represented as hanging from the branch of a tree, and just above there is another, which is about to settle.

On account of their large size they are very conspicuous, and look very much like great bunches of fruit growing from the boughs. I have a photograph of an Indian fig-tree, the upper branches of which are thronged with Kalong bats. They hang in regular rows, and the resemblance which I have just mentioned is so strong, that every one to whom I have shown the photograph has, as a matter of course, taken them for large fruits.

Mr. Bennett, in his "Whaling Voyage," mentions that if they are disturbed by striking the trunk of the tree, they spread their wings, and fly off to some other place of refuge. One peculiarity in their flight is the regularity with which it is accomplished, the bats flying in long lines, and not singly or in a shapeless group.

The cry of this bat is much like the short, sharp bark of the deer.

Living upon fruit, they do very great damage to the crops; and in spite of nets, baskets, and other protections, they will sometimes manage in a single night to strip a tree of every ripe fruit, leaving the unripe alone. I have seen this bat eating apples, and a very curious sight it was. The animals were hanging by their hind legs, and seemed to consider that to be the most agreeable position for taking their meals. Their large brown eyes looked rather excited as they fell on the fruit; but, as soon as the repast was finished, they were closed again, the head tucked up against the breast, and the animal was fast asleep.

In Tunis and the neighbourhood, there is a very large species of these fruit-eating bats, called the Edible Kalong (*Pteropûs edulis*). As its name implies, it is used for food; so that the owners of the fruit-trees revenge themselves for the loss of their crops by eating the robbers. The flesh of this Kalong is said to be very delicate and white. I may mention here that the generic name of Pteropus is formed from two Greek words, and signifies wing-footed.

THE COLUGO, OR FLYING LEMUR (*Galeopithecus volans*).

Although there is no aquatic form of the monkey tribes, we have one which may well take its place as a trespasser in the air, namely, the singular animal called the Colugo, or Flying Lemur, which inhabits many of the islands of the Indian Archipelago.

In a sort of way, many monkeys are partial trespassers upon the air, being able to fling themselves from one branch to another, and so to pass through considerable distances. The Gibbons are specially celebrated for their aërial feats, being able to launch themselves through distances of forty feet or so.

These animals, however, do not possess any capability of sustentation in the air; and, if they were to miss their aim, would fall heavily to the ground. The Colugo, however, has a power of sustentation which may be called a modified flight; and, although it cannot rise in the air, it can at all events pass for considerable distances through it, and direct its course.

Putting aside the very great length of the fore limbs, and especially of the fingers, the structure of the Colugo is wonderfully like that of the bats. Indeed, so close is the resemblance, that naturalists were long undetermined where to place it: whether at the end of the monkey tribe, or at the head of the bats.

In this animal the skin of the sides is modified into a membrane much resembling the wing of the bat, except that it is covered with hair upon the upper surface. This membrane extends to both pairs of feet. It also passes from the hind feet to the tip of the tail, and from the fore feet to the neck, so that when the limbs are extended, a very large and flat surface is presented to the air, not so large as that of the bat tribes. but still of very great extent.

Like all the monkey tribe, the Colugo is arboreal in its habits, but has a rather peculiar mode of passing from tree to tree. It does not take the trouble to descend to the ground, run to the desired tree, and

CUT 12.—COLUGO.

ascend it, but takes exactly an opposite course. It ascends to one of the topmost branches, makes a spring in the direction of the spot which it wishes to reach, and spreads out its limbs to the fullest extent. It then skims through the air much after the manner of an oyster-shell or a piece of slate when used in making "ducks and drakes," and can in this manner pass over a distance of a hundred yards or so without coming to the ground.

Perhaps the reader may say that the oyster-shell or slate rotates, while the Colugo cannot do so. That is true enough, but the rotatory motion has nothing to do with the skimming movement of the missile through the air. It only serves, according to the well-known law by which the arrow and the rifle-bullet are kept steadily in their course, to preserve the missile in its proper position; and as the Colugo can do this by means of the inflection of its body, rotation is not needed, and is therefore not employed. In point of fact, the Colugo is sustained in the air on precisely the same principle as is a boy's kite, the relationship of forces being identical in either case, although they are applied in a rather different manner.

A figure of the Colugo, shown as it appears while passing through the air, is given in Cut 12. The reader will notice the singularly close resemblance between this animal and the flying petaurist, which is shown in the lower corner of Plate V.

Among the points in which the Colugo resembles the bat tribe, two may be specially mentioned. In the ordinary monkey, the mammæ are placed upon the breast, whereas in the Colugo they are set upon

the lower part of the abdomen, exactly as in the bats.

The second point is the position assumed while the animal is at rest. The ordinary monkeys, whether of the Old or New World, gather themselves up into as small a space as possible, just as birds tuck their heads on their shoulders, and so court their sleep. But the Colugo acts exactly as the bats do, and when it retires to rest, it slings itself from a branch by its hind legs. It is, therefore, no matter of surprise that naturalists should so long have been perplexed as to the real position of this extraordinary animal.

In size the Colugo equals a large cat, and when it is walking or climbing among the branches, the membranous skin which converts it into a living parachute clings so tightly to the body by its own elasticity, that it is scarcely visible. The name Galeopithecus is formed from two Greek words, and literally signifies weasel monkey.

THE SQUIRREL PETAURIST, OR SUGAR SQUIRREL (*Petaurus sciureus*).

We have already seen that there are examples of water trespassers among the Marsupial or Pouched animals, and shall now find that several air trespassers are among them.

These animals are comprised in an Australian group, which is technically named Petaurist, from a Greek word signifying a rope-dancer, and alluding to

the manner in which they balance themselves on the slender branches of the trees which they frequent.

One of the prettiest of these animals is shown in the lower corner of Plate V., and is popularly known as the Sugar Squirrel, though it is not a squirrel, or even a rodent, and though the sugar-cane is not an Australian plant.

The general structure of this animal is very much like that of the colugo; and, indeed, it would be easy to put a colugo among a number of petaurists, and for the distinction between them not to be noted, except by a tolerably skilled naturalist. In the petaurists, the skin is extended exactly as it is in the colugo, the principal difference lying in the tail. In the colugo, the skin-membrane extends to the end of the tail, but in the petaurists it gets no further than the root of the tail. This organ, however, is clothed with very long and dense hair projecting on either side, and answering the same purpose which is fulfilled in the colugo by the skin membrane.

The animal which is represented in the illustration is a pretty little creature, measuring about eight inches from the nose to the tip of the tail. It is rather remarkable that the tail is just as long as the body, and as it is clothed with very long hair, it adds much to the power of sustentation as the creature takes its sweeping flights.

The power of flight, if we may so call it, in this creature is very remarkable, one of these animals having been seen to leap across a river forty yards in width, though it only started from an elevation of thirty feet.

It is a lively and playful little animal as soon as the dusk sets in, but remains perfectly quiet during the daytime. These nocturnal habits are common to all its kind. One of these curious marsupials, which belonged to a friend of mine, used to spend the whole of the day in a bag which was hung from the back of a chair. In this curious hammock it lay quietly sleeping until the evening, when it began to move, and by scratching or kicking showed its desire to be released. As soon as the bag was opened, the animal went to the place where a saucerful of bread and milk was placed for it, and then began its graceful gambols.

The largest of these animals is the Petauriste (*Petaurista taguanoides*).

In spite of its size it is seldom seen in a living state by white men. In the first place, it is nocturnal in its habits; and so completely can it trust to its wing-like membranes, that it seldom comes to the ground, passing through the air from tree to tree.

Moreover, it dwells during the day in hollow trees; and trusts so completely to the security of its hiding-place, that even when the axe lays open its dwelling, it refuses to stir, but crouches in the furthest corner. It is no coward, however, for it can and will fight in the most desperate manner when fairly driven to bay, using both its teeth and claws with great force and quickness. Even the dexterous native hunter does not dare the combat, but as soon as he has cut a sufficiently sized hole in the tree-trunk, he seizes the animal by the tail, swings it round and dashes its head against the tree before it has recovered itself sufficiently to think of using its teeth or claws.

The specific name of Taguanoides, or taguan-like, is given to the animal in consequence of the resemblance which it bears to the Taguans, or Flying Squirrels of the Old World; a similitude, indeed, which is so close, that a sketch of one of these animals would be no very unfaithful representation of the other.

Scarcely smaller than the Petaurist is the Hepoona Roo (*Petaurus Australis*), sometimes called the Great Flying Phalanger.

I may here mention that the general name of Phalanger is applied to the whole of this group, on account of the length of the phalanges, or joints of the toes.

The present species is a native of New Holland, and was at one time plentiful; though, like all wild animals, it became scarce in the presence of civilization. The full length of the body rather exceeds a yard; but very nearly half of this measurement belongs to the long and woolly tail.

It is a prettily coloured animal; but the beautifully contrasting tints of the fur are scarcely to be seen except when the animal spreads itself for flight. In that case the cream-white of the under surface affords an admirable contrast to the deep, warm brown of the upper surface. When the animal is at rest, the only indication of this contrast of colour is a waving line of cream-colour along the sides, marking the edge of the flying membrane. The colour of the fur is, however, very variable; and in some cases, both surfaces are nearly white.

The smallest of the Petaurists is the pretty little

animal which is popularly called the Opossum Mouse (*Acrobates pygmœus*).

It is barely as large as our common mouse, measuring about three inches from the nose to the root of the tail. The tail is as long as the body, and is stiffly feathered on either side; so that it not only aids in sustaining the body in the air, but also acts as a rudder whereby its course can be directed. The distances through which this beautiful little creature can project itself are really wonderful; and it can alter its aërial course with so much ease, that most persons who see it for the first time, have some difficulty in believing that it is not a bird.

A figure of the Opossum Mouse is given on Plate V., on the same level with the suspended kalongs.

FLYING SQUIRRELS OF THE OLD WORLD.

Nature, as well as history, repeats herself. This fact is specially familiar to entomologists, who find the same types of form and colour repeated through many of the various orders. In the mammalia, we have a similar repetition in the flying lemur, which belongs to the monkey tribe; the flying petaurist, which belongs to the marsupials; and the flying squirrels, which belong to the rodents.

And, so close is the resemblance, that I am certain that if thirty or forty living specimens of all these three groups were placed in a room wherein they had ample space to exercise themselves, and to display their forms to the best advantage, not one in a hun-

dred of ordinary spectators would be able to say which was monkey, which was rodent, and which was marsupial.

It is rather a remarkable fact, too, that the largest species of these groups resemble each other in size as well as in form. Take, for example, average specimens of the colugo, the petauriste, and the taguan, and there will be but an inch or two difference between them, either in length or breadth. Again, not only are all these animals furnished with the skin membrane that enables them to take their aërial flight; but their toes are elongated in a manner very similar to that which we have seen in the phalangists.

In the Taguan, the membrane is greatly developed, reaching to the roots of the toes of the fore feet, and to the heel of the hind feet. The habits of this and the other flying squirrels are almost identical with those of the petaurists, except that the former are not nocturnal in their habits. Their generic names all allude to their power of flight. For example, the Taguan belongs to the genus pteromys, or winged mouse; the word which is here translated as mouse being widely used in Greek to represent any rodent animal of moderate size. Other Taguans and Assapans belong to the genus sciuropterus, or winged squirrels.

Like most of the active rodents, the Flying Squirrels are very capable of domestication, and will soon learn to prefer the society of human beings who are good to them, to that of their own kind. There is a singularly interesting account of a tame Flying Squirrel, given by Miss Eden, in her charming work, "Up the Country," Vol. II., p. 130. As her little

biography does not refer directly to its flying powers, I cannot insert it in this work.

Suffice it to say, that she describes her pet as being the "most coaxing animal she ever saw;" and narrates the manner in which he would persist in making his way into her room at night. Although shut up in an apartment at some distance from that of his mistress, he contrived to break a window, to make his way into the garden, where he had never been before, and then to scramble up the wall until he came to the open window of his mistress's room. He was so very fond of her that he woke her by licking her face.

She had the broken window stopped up, shut him up afresh, and again courted sleep. In a few minutes, however, she was again awoke by the Squirrel patting her ear; whereupon she gave up the attempt at coercing him, rolled him up in the mosquito curtain, and allowed him to remain there for the rest of the night.

CHAPTER XIII.

Flying Reptiles, Fishes, and Molluscs.

Passing by the birds, which may be considered as naturally denizens of air, and which may not therefore be counted among the trespassers, we come to the next great class of animated beings—*i.e.*, the Reptiles.

As the word Reptile, being formed from the Latin word Repo, signifies something which creeps, we would scarcely expect to find among them any species which were trespassers on the air.

Another example of Nature repeating herself now comes before us. I had seriously debated with myself whether I ought not to include in this work the many Reptiles which in the ancient times of this world occupied the same place which the bats do at the present day. As, however, the book would extend to an inconvenient length if the various extinct species were recorded in it, I shall only give a very brief notice of them.

The reader will naturally call to recollection the

wonderful Flying Lizards, which seem to have been so plentiful in the ancient times, and which we now know by the general term of Pterodactyls. This word signifies wing-fingered, and the name is given to the animals because, like the bats, they were enabled to fly by means of a membrane which was stretched between the elongated joints of the fore limbs.

It is worthy of notice, by the way, that in these reptiles of an extinct age, the wing seems to have depended for its power principally on that joint which in the animals of the present time is the weakest—namely, the fifth, or, as we should call it, the "little" toe or finger. In the various Pterodactyls, however, the first four toes are only moderately elongated, whereas the fifth is not only drawn out until it is nearly as long as the head, neck, and body put together, but its two basal joints are as thick as those of the arm itself, and rather longer.

Of the habits of these creatures little can be known, but the shape of their teeth shows that they must have been carnivorous, seizing their prey and swallowing it without any power of mastication. They varied much in size, some species being about as large as a pigeon, while others measured several feet across the extended wings. How these extraordinary animals looked when in life, the reader may easily see by visiting the Extinct Animals' Department in the grounds of the Crystal Palace, where the art of Mr. Waterhouse Hawkins has reproduced the forms of these and various other animals, which are now known only by their fossil remains, and shows us how strange and almost grotesque were the creatures which in-

habited the earth before we have any traces of man's presence upon it.

One of the Flying Lizards of the olden time was remarkable for having a very long tail.

FLYING DRAGON (*Draco volans*).

At the present day we have no examples of Reptiles which can really fly, though we have some which, like the Flying Squirrels, are able to sweep for some distance through the air.

These animals are known by the popular name of Flying Dragon, in consequence of their resemblance to the conventional dragon of fables. There are several species of them, all agreeing in form and general habits, and all being quite little creatures, the body only measuring a few inches in length. The tail is very long, very slender, and tapers to a sharp point.

The structure by which these reptiles are enabled to pass through the air is very remarkable. As the reader may see, by reference to Cut 13, the sides of the body are expanded like those of the flying squirrels, but the expansion is obtained in a different manner. In the flying squirrel, the skin of the sides is expanded with a membrane, which is opened by stretching out the legs; but in the Flying Dragon the ribs are employed for the purpose.

I suppose that the reader knows the difference between the two kinds of ribs. There are the "true" ribs, which occupy the upper part of the chest, and which have their ends resting on the breast-bone;

and the "false" ribs, which occupy the lower part of the chest, and which have their ends free. It is by means of the latter set of ribs that the expansion of the sides is managed.

The false ribs, instead of being, as they usually are, much shorter than the others, are greatly lengthened, or, to be more accurate, they are furnished with very long and slender appendages. These additional bones are so joined to the ribs that they can be spread out laterally, or laid against the sides at the pleasure of the animal. When they are spread, they very much resemble the sticks of an opened fan, and as they are connected with each other by a membrane which is formed from the skin of the sides, they offer a very wide surface to the air.

The movements of the Flying Dragon are curiously like those of the flying squirrels of the Old World, and the flying marsupials of Australasia; and, indeed, if the Flying Dragon and the opossum mouse were simultaneously to spring from one tree to another, their sweeping flight would be almost identical, and it would not be easy to distinguish between the two animals.

There is another point in the structure of the Flying Dragon which has been thought to have some effect in increasing its buoyancy when in the air. In common with many arboreal lizards, it possesses a large pouch under the throat, which it is capable of inflating to a very great extent. When the lizard is preparing to launch itself into the air, it inflates this sac simultaneously with spreading its wings, if we may use this term to express its peculiarly constructed

CUT 13.—FLYING DRAGON AND FLYING FROG.

side. Many naturalists have thought that the principal object of this sac is to increase the buoyancy of the animal while in the air. It does probably have that effect, but I do not think that buoyancy is its chief object, for the reason that the inflatable pouch is found in many lizards which do not possess the expansible sides, nor the power of skimming through the air.

The Flying Dragons are tolerably plentiful in Borneo, Java, and the Philippine Islands.

FLYING FROG.

I presume that my readers are familiar with the pretty Tree Frogs, which are now so plentiful in ferneries. Their habits are curiously contrary to those of the ordinary frogs, for they abandon both earth and water for the trees, and lead an arboreal, and not a terrestrial or aquatic life, as do their fellows.

In order to enable them to ascend trees, they are furnished with sucker-like appendages at the tips of their toes, and with these they can cling firmly to any smooth object, such as the trunk of a tree, the surface of a leaf, or even a flat piece of glass.

In the last-mentioned case, it is interesting to examine with a magnifying lens the structure of the suckers as they are pressed against the glass, and to note how instantaneous is their action of exhausting or admitting the air at will. This structure, indeed, is absolutely necessary for the creature's existence. It lives upon insects, and if it were to depend for its

subsistence upon those which come within its reach, it would stand a very good chance of starving. But, aided by these marvellous developments of the feet, it is able to spring at a passing insect, to catch it, and to affix itself instantaneously to another branch or leaf.

There are many species of Tree Frogs, spread over a large portion of the earth, but the most remarkable at present known is the Flying Frog of Borneo, which was discovered by Mr. A. R. Wallace in 1865. It was brought to him by a Chinese workman, who saw it skimming down from a high tree, in a slanting direction, evidently upborne by the webs of its enormously long toes.

If the reader will refer to Cut 13, he will see the Flying Frog shown in the act of passing through the air, its toes being widely spread, so as to stretch the membrane which connects them. In proportion to the size of the reptile, the extent of surface which can be thus opposed to the air is very great. The body of the Frog is about four inches in length, while the web of each hind foot covers a space of four square inches, and if the webs of all four feet be put together, they will be seen to equal a space of twelve square inches. It is evident enough, therefore, that a creature which is only four inches in length, and which is able to spread a flat membrane of twelve square inches, would be upborne for some distance through the air, if it only projected itself with some force.

In this curious reptile, then, we have another of the many ways in which a very simple variation of structure is sufficient to make the creature a trespasser.

Except that the limbs do not seem to be moved when the Frog passes through the air, there is but little difference between the structure of the bat's wing and the membrane of the Flying Frog, each being nothing but an existing membrane developed and expanded by being attached to the lengthened toes. In order, also, to assist in the buoyancy of the creature, the body is capable of considerable inflation.

In life it is a very handsome species. The back is rich deep green, and the under surface yellow. The webs are black, adorned with streaks of yellow.

Probably these enormously developed feet are used for swimming as well as for flight, and in that case they will form a remarkable analogy with the wings of the extinct Pterodactyls, which are proved with tolerable certainty to be organs adapted to the water as well as to the air.

FLYING FISHES.

Passing from the reptiles to the next class of beings, we come to the Fishes, and shall find among them several examples of air trespassers.

The first in order of these creatures is necessarily the Flying Fish (*Exocœtus volitans*), which we will take as an example of some thirty species, all resembling each other in general form and habits. They are only found in the warmer seas, and Mr. Bennett, who has observed these fishes very carefully, states that he has never seen them further north than lat. 36° N.

They have long been famous for their powers of leaving the water; and, indeed, the generic name, Exocœtus, which is formed from two Greek words, signifying sleeping out, was given to these fishes by the earlier naturalists, because they believed that the Flying Fishes left the sea at night, and went on shore to sleep.

In all these fishes, the pectoral fins are enormously developed, so that when they are extended they look exactly like wings, and perform very similar functions. Whether urged by fear, as some persons think, or by sport, as others think, these fishes are in the habit of springing out of the water, and of being upborne by their wing-like fins in the air.

The mode in which this feat is achieved is identical in principle with that which enables the air trespassers which we have already noted to support themselves in their aërial journeys. Just as in the Flying Colugo, the Flying Squirrels, the Flying Marsupials, the Flying Dragons, and the Flying Frogs, the membranes by which they support themselves in the air are folded closely to the body while the creatures do not require to use them, so in the Flying Fishes the great pectoral fins are folded into a very neat and compact form while the fish is swimming, and do not interfere in the least with their owner's progress through the water. Whether or not they are used in swimming is a doubtful point, but in all probability they can be used in guiding the course and balancing the body, just as if they had been no larger than those of ordinary fish. In some species the ventral fins are also very large, so that the creature appears to have four wings.

The mode by which the Flying Fish propels itself through the air is this. By means of the backward and forward movements of the tail, it springs completely out of the water, just as the salmon does when it makes its leap. Simultaneously, it spreads its wing-like fins, and is borne upon their wide surface to a considerable distance. See Cut 14.

When alarmed, it has been known to pass over a space of two hundred and fifty yards, and to remain in the air for half a minute. The average length of flight appears to be about one hundred and fifty yards. The fish dashes into the air with such force that its wings produce a distinctly audible ruffling sound.

Accounts are very conflicting concerning the movement of the wings. It is certain that they possess some power of directing their course in the air, as is their function in the water. But whether or not the wings are moved like those of birds seems to be an open question, witnesses differing diametrically in their accounts. I never saw the Flying Fish alive, but I should very much doubt whether its flight is more than that of the flying dragon—*i.e.*, a mere sustentation in the air until the force of the spring is exhausted.

The Flying Fishes are sociable, a solitary one being seldom seen; and when a number of them are seen starting into the air at once, they present a very pretty sight, their broad, white, transparent wings gleaming in the sun in beautiful contrast with their blue bodies.

The force with which these fishes can drive themselves out of the water is so great, that they not

only shoot to considerable distances, but can impel themselves to such a height that they can pass completely over the hull of a ship, and frequently are known to strike among the rigging or against the sails, and fall upon the deck. As their flesh is in much repute, the sailors will sometimes hang lanterns on the rigging at night, for the purpose of attracting the Flying Fish, which, when starting out of the water, are sure to make for the light, as do many other creatures which are more nocturnal in their habits.

Perhaps the best time to see the Flying Fish in perfection is when a shoal of them is chased by the splendid and voracious Coryphene, a fish which the sailors *will* persist in calling by the name of dolphin. The Coryphene, as soon as it sees its prey, dashes at it like a greyhound at a hare, springing out of the water as if it too were about to take a flight. The Flying Fishes soon see that they are pursued, and when they drop upon the water, spring off again at an angle, just like a hare doubling upon a greyhound, hoping thereby to elude their terrible pursuer.

But the Coryphene is too sharp-sighted to be deluded in that manner, and as the Flying Fishes alter their direction, so does the Coryphene alter its own course. In their power of flight the Fishes have some advantage over their enemy, but the advantage does not hold good for long. The speed of the Coryphene is fully twice as much as that of the Flying Fish, and its endurance much greater. Their flights become shorter and shorter, while the leaps of the pursuer seem to become, as Capt. Hall says, more vigorous at each bound.

CUT 14.—FLYING FISHES, FLYING GURNARD, FLYING SQUID.

At last, the poor Flying Fishes become too exhausted to continue the race, and, one by one, they fall into the jaws of the Coryphene, which exactly times its leaps so as to receive them as they fall back into the water.

There are one or two points about the air trespassing structure of the Flying Fish which are worthy of notice. The first is, that the pectoral fins or wings are set very much higher on the back than those of ordinary fishes, so that when the fish is in the air the centre of gravity is much below them, and the balance is rightly preserved.

The organ of propulsion in the Flying Fish is the tail, which is large, and lengthened into two long and sharply-pointed lobes, the lower much exceeding the upper in length. It is thus formed into an exceedingly powerful instrument, and it is by the violent sideways movement of the tail that the fish can project itself into the air. It is worthy of remark that the tail of its terrible pursuer, the Coryphene, is constructed after a similar principle, the lobes being long, and each running to a sharp point.

Yet another point in which the air trespassing power of the Flying Fish is increased. The reader will remember that I have already mentioned sundry contrivances for ensuring buoyancy when needed. A similar provision is found in the Flying Fish. The air-bladder is of very great size, and when fully inflated, occupies nearly the entire cavity of the abdomen. Besides this, there is a corresponding arrangement which renders the fore part of the fish equally buoyant, and this is done by means of a mem-

branous structure in the mouth, into which air can be drawn through the gills.

Thus we have in the Flying Fish another instance of the wonderful and yet simple manner in which a slight alteration or development of existing structures enables an animal to adapt itself for a time to a different kind of life.

There is a well-known group of fish called by the popular name of Gurnards, and which have the pectoral fins enlarged or otherwise modified in a most singular manner. Many of them are exceedingly beautiful creatures, the pectoral fins being adorned with spots and stripes of brilliant scarlet, crimson, green, or blue. No idea can be formed of the real beauty of these lovely fishes unless they are seen alive, and this can now be done in the great aquaria which are built in different parts of England.

Several of these fishes are known as Flying Gurnards, because, like the Flying Fish, they are able to propel themselves for some distance through the air, upborne on their enormous pectoral fins. Those fins are, however, not long and sharply pointed, like those of the Flying Fish, but they afford the same proportionate surface to the air by being rendered very broad and rounded. In them the membrane does not extend quite to the end of the rays, which project like a fringe from the outer top of the wing.

It is worthy of notice that, in order to increase the width of the fin, and at the same time to give it the necessary strength, the rays are not only very long, but are greatly increased in number.

One of these fishes is represented in the middle of Cut 14, and is shown in the act of flying, its pectoral fins being extended to the utmost. When the fish is swimming, the fins are laid along the body and directed downwards. I have seen the Gurnards in the Crystal Palace use their fins like legs, crawling with their aid upon the bed of the tank.

The species which is shown in the illustration is the common Flying Gurnard (*Dactylopterus volitans*), and is common enough in the Mediterranean. It sometimes reaches the length of fifteen inches, and is altogether larger than the Flying Fish. It is a lovely creature when living, its beauties, however, being mostly confined to the pectoral fins. The body is mostly brown, tinged with red below and on the sides. The pectoral fins are black, but covered with spots and mottlings of light azure, so that when spread they look very much like the wings of some gorgeous butterfly.

Altogether four species of Flying Gurnards are known, but the present species is a good example of all four.

Other fishes have the power of springing out of the water, and shooting for some distance through the air.

There is, for example, the Gar-fish, a long, slender, and almost eel-like fish, which has both its jaws drawn out to a very great length, wonderfully attenuated, and very sharp at the tip. Mr. Bennett, while describing the island of Raitea, has the following remarks on this fish: "Gar-fish infest the harbours in large shoals, often darting through the air in a horizontal

direction, and with a force which has caused their long and slender jaws to penetrate the planks of a boat."

FLYING CUTTLES.

Perhaps the reader may have seen the Cuttles which at one time caused such a sensation at the aquarium at the Crystal Palace, and the discussion which arose in the journals as to the right pronunciation of the name "octopus." They may not be aware that some of these molluscs have the power of leaving the water and darting through the air; and that they can skim as far as can the flying fish itself.

As far as the semi-aërial part of its life goes, the Flying Cuttle has many points in common with those fishes. It is gregarious, not only in the sea, but when it takes its leaps into the air, at which times great flocks of them come flying out all at once. As is the case with the fish, this simultaneous flight is mostly caused by attacks of a marine foe, mostly the albacore, which is also one of the enemies of the flying fish. Like the various fishes that are able to rise into the air, including the gurnards, the Flying Cuttles have their foes of air as well as those of water; and, while flying from the attack of the albacore below, are snapped up by the various sea birds which hover above.

These flying molluscs belong to a group which are popularly called Squids, and which, as a rule, are about as large as the flying fish. Sometimes, however, they reach to an enormous size, as has been casually

mentioned on page 28, when treating of the spermaceti whale.

Dr. Schewediawer's account has been recently corroborated by a communication sent by the Rev. Mr. Harvey to the Natural History Society of Montreal. Some fishermen saw floating near St. John's, Newfoundland, something which they took to be a wreck, and struck it with a gaff. It proved to be a gigantic cuttle, shaped, and moving like a squid; and on being struck, it wrapped two enormous arms over the boat. These the men cut off with an axe, when the creature moved off, ejecting at the time its ink to such an extent as to darken the water for some distance. They afterwards saw it with its tail in the air, the width of which they estimated at ten feet.

They considered that the total length of the creature must have been about sixty feet. This seems an enormous measurement, but is carried out by the dimensions of the arms, which were brought ashore. The people not knowing the value of the acquisition, destroyed one, and had already cut off six feet of the other, when Mr. Harvey rescued it. The portion which he saved measured nineteen feet in length; and if we add to that the six feet which were lost, and the ten feet which the men estimated to have been left on the cuttle, their measurement is not very far from correct. The arm was not much more than an inch in diameter, except at the tip, where, however, it was six inches. The arm was plentifully beset with suckers.

A clergyman told Mr. Harvey that while he was at Lauraline, two Cuttles were thrown ashore in the

winter of 1870, one measuring forty feet in length, and the other forty-five.

We will now see how the Squid is able to propel itself into the air.

All those who watch the Cuttles in the aquarium, must have noticed their remarkable mode of progression. As long as they are on the bed of the tank, or near the sides, they crawl, or haul themselves about, using their tentacles by way of legs or arms. But they may occasionally be seen to shoot through the water, with their tentacles trailing behind them.

This is done by means of the "siphon," a tube which is connected with the respiratory apparatus. For the purpose of respiration, water is drawn into the body through the siphon, passes over the gills, and is then expelled through the aperture into which it entered. When this is done gently, no effect is produced in the movements of the animal. But if the water be violently ejected, the Cuttle is propelled backwards by direct action, on exactly the same principle as a rocket is impelled through the air. Even the large-bodied and comparatively sluggish Cuttles can thus shoot at some pace across a tank; while the slight-bodied, active Squids can drive themselves with such velocity as to project themselves into the air.

Here is an extract from Mr. Bennett's "Whaling Voyage," in which he gives a very good account of the Flying Squid. There are one or two trifling errors, which I will mention at the end of the extract.

"Many different kinds of Loligo are called by sailors Flying Squid, from a habit they have of leaping from the water, and proceeding through the air to

some distance in a horizontal direction, like the flying fish.

"The head of this cephalopod is a plane, circular disc, surrounded by long arms, furnished on their upper surface with many small circular suckers, which hold with a tenacious grasp. The eyes are large, very perfectly formed, and lodged in capacious cartilaginous orbits. The mouth, like that of most of the cuttle fish tribe, is horny, and shaped like the beak of a parrot. A slender neck connects the head with the body, and is received into the latter as into a capacious sheath. The trunk is conical, tapering to a point at the tail, smooth, and composed of a dense white semi-cartilaginous structure, covered with a delicate membrane, or skin, beneath which are deposited the brilliant colours this mollusc often displays.

"Near the tail there is a broad fin-like appendage, which can either be expanded horizontally on either side, or folded neatly upon the abdomen. The interior of the back contains an elastic horny rod, or substitute for the 'sepia bone' that occupies the same part in other tribes of cuttle fish. It extends the entire length of the body, and is flattened at its anterior extremity, whilst its caudal end is shaped like a cup, the whole bearing some resemblance to the instrument used for tasting wine from casks. This elastic structure, and the membranous expansion on each side of the tail, are apparently the two principal agents employed by the animal in its protracted leaps through the air. Whether the fin-like appendage is also employed in swimming is very questionable.

"One kind of Loligo, which we captured in the Pacific Ocean, in lat. 34° N., measured six inches in its entire length. The upper surface of the body is grey, freckled with purple, the under white; iris silvery, pupil jet black and prominent. It has eight arms and two tentacles. Each arm is furnished with a double row of suckers on its entire length, and all, with the exception of the first or dorsal fins, have a loose membrane floating from their posterior surface. The two tentacles are round, slender, and twice the length of the arms, and have at their extremity a broad sickle-shaped membrane, covered with two rows of yellow hooks of different sizes.

"This individual leaped from the sea over the high balustrades of the ship, and alighted on the deck, at a time when vast flocks of the same species were seen leaping around, and after striking with violence against the bows of the vessel, the sea being comparatively smooth. The creature was much injured by the violence with which it had struck the deck, and showed little animation: it did not attempt to leap or swim when put into a bucket of sea-water, though it emitted a quantity of inky fluid through a canal in the body, opening by a large orifice immediately below the neck. This secretion is contained in a narrow oblong bag of silvery hue, and placed immediately below the stomach.

"The prehensile power of the suckers on the arms was retained for a considerable time after the death of the animal; from which I should judge that, like the buckles of the sucking fish, their function in a great measure depends upon solely mechanical causes.

"A second species, which we also obtained in the Pacific, resembled the above in size and form, but its two long tentacles were furnished at their extremities with rows of suckers (*acetabula*), instead of horny, hooked appendages. The prevailing colours of this species are silver-white and steel-blue, spread with red spots and tints of violet and purple, a brilliant and very beautiful spot of emerald green being placed immediately above each eye. We noticed examples of this family of cephalods from the Equator to lats. 34° N. and 160° S., Pacific Ocean."

In this interesting account there is one decided error, namely, in thinking the posterior fins or flaps at either side of the sharply-pointed tail to be the instrument of locomotion. This is not the case, for the animal always flies tail foremost, and must in that case turn round in the air, which would decrease its impetus. The real organ of propulsion is the siphon which has just been described.

The species which Mr. Bennett first mentioned belonged to the genus *Onychoteuthis*, or Hooked Cuttle, so called from the hooks upon the ends of the tentacles.

FLYING SPIDERS.

The last of the air trespassers for which I have space are those little spiders which are known as Gossamer, and which float so plentifully in the air that they sometimes become very annoying to persons who are out in the open air.

The end of summer or the beginning of autumn is the best time for witnessing this remarkable phenomenon. Sometimes the Gossamer threads are so numerous that a number of them become attached to each other, and form large, light, flake-like masses. In the early morning, before the dew is off the grass, the fields present a wonderfully beautiful appearance, the ground being covered, as far as the eye can see, with snowy-white flakes, every line of which is studded with multitudinous dewdrops glittering in the sunbeams like rubies, sapphires, and emeralds.

This is one of the many beauties of nature that is lost by those who do not rise early, and I am quite sure that no one who has tasted the pleasures of a country walk just after sunrise will be likely again to waste the sweet morning hours in bed.

The reader will probably have noticed that I have mentioned Flying Spiders in the plural, and not the singular number. The reason is, that the term Gossamer Spider is only a general one, which is applicable to a considerable number of species, mostly while the creature is still young and light. The mode in which the ascent is made is as follows:—

The little Spider climbs a branch or plant, or even a large stone, and raising its abdomen upwards, proceeds to emit from its spinnerets a fine thread. This streams upwards in the air, which radiates from the heated ground, and when the spider feels the upward pull, it loosens the hold of its feet, and sails away into the air, than which it and its thread parachute are a trifle lighter.

As to the mode of its descent, I imagine that to be

caused by the deposition on the thread of the moisture which is floating in the air, and which may be seen on the threads as I have described, glittering like rows of gems.

The reason for these aërial excursions is not very well ascertained, but, in all probability, food has something to do with it, as if the threads be intercepted while in the air, and carefully examined, they will often be found to have captured very minute insects, which have adhered to their viscid surface. These insects are so small that they are scarcely visible to the naked eye, and would, in all probability, not be captured in any other way. In size they are very suitable to their captor, who is seldom larger than the tiny spiders which are popularly called money-spinners, and which are thought by some persons to bring good luck to those on whom they may happen to settle.

A very good account of the Gossamer Spiders and of their flight, may be found in Mr. Blackwall's splendid work on the British Spiders.

CHAPTER XIV.

Earth Trespassers.

PART I.

TRESPASSERS FROM THE WATER UPON THE EARTH.

I SHALL divide this subject into two portions—namely, Trespassers *upon* the Earth, and Trespassers *in* the Earth. The former portion will comprise those remarkable creatures which breathe by means of gills, and are properly denizens of the water, but which are able, by means of a simple modification of the breathing organs, to exchange the water for the land, and to live for a considerable time on shore without needing to return to the water.

We will begin with the celebrated Climbing Perch (*Anabas scandens*). This remarkable fish is spread over a considerable part of Asia, and is tolerably plentiful in Ceylon.

The reader may remember that I have already mentioned, when treating of air trespassers, that the gurnard is able to use its large pectoral fins like legs, and

with their assistance to crawl along the bed of the tank. In the Climbing Perch, not only the pectoral, but the ventral fins are used for this purpose, the sharp points of the rays being very strong, and enabling the fish to hitch itself along the ground, much as the snakes do by means of the projecting edges of their ventral scales.

Aided by these modified fins, the Climbing Perch is able not only to crawl about on the bed of the river, but to go ashore and walk on the dry land, travelling for considerable distances, and making its way over obstacles which no fish would be thought likely to surmount, and which would be absolutely insurmountable by many an inhabitant of the land.

We shall presently revert to this part of the subject.

This modification of the fins is seen to be developed in a most remarkable manner in the Walking Fish (*Antennarius hispidus*), which is shown on Cut 15, just below the figure of the Climbing Perch. This is one of a large group of fishes in which the pectoral fins are set at the end of a pair of arms or legs, caused by an elongation of the carpal bones. The external aperture of the gills is exceedingly small, being reduced to a little slit which is so small as almost to escape observation. The well-known Frog Fish, or Fishing Frog (*Lophius piscatorius*), belongs to this group.

One species, which was obtained by Mr. F. D. Bennett at Oahu, remained alive for many hours after it had been taken out of the water. "During this time, its abdomen and throat remained distended to a great size; but previous to death, both air and water

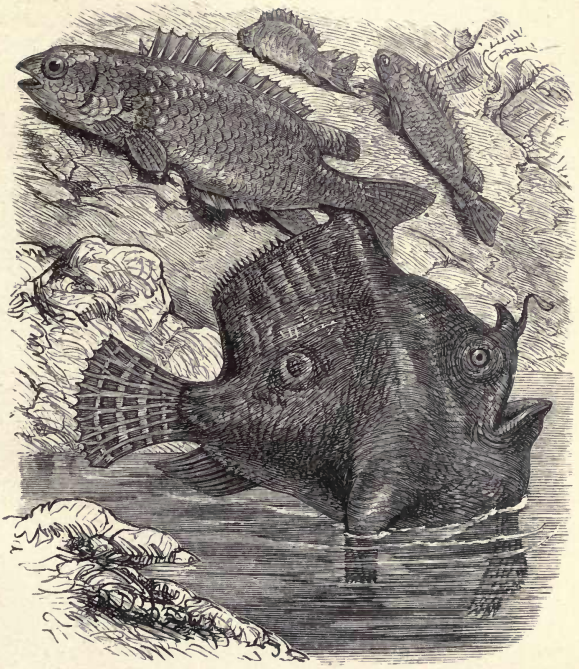
were evacuated from the mouth, and the body collapsed. Dissection proved that the cavity of the stomach was the part thus distended. This fish has no ribs, though it has a very distinct sternum. Its swim bladder is small, and of ovoid form.

"The native name for the fish is *O óbu te tai*, or the Sea Belly, expressive of the power it has of inflating the abdomen to a large size."

These fishes are all tropical, and are mostly found upon the vast masses of floating seaweed which are so characteristic of these seas. Their peculiarly formed leg-like fins aid them in walking over the weeds, and they are further aided by their power of inflating the body.

Perhaps the reader may ask for the reason why the Climbing Perch should be able to pass so much of its time upon the land. It is to be found in the climate and physical geography of the country in which they live. The climate is hot, and the supply of water is uncertain. Hence, if fishes are to exist at all, the conditions of existence demand that they should not require much water for respiration, that they should be able to procure that limited supply of water wherever it may be found, and that the means of transit shall be supplied to them. If all or any of these conditions be missing, this group of fishes must perish.

Now in the warmer parts of Asia, where these fishes most abound, the supply of water is very uncertain, and the pools become less and less in proportion to the want of rain, sometimes drying up altogether. Thus, the fish is in the proverbially unpleasant position of being not only out of water,



CUT 15.—CLIMBING PERCH AND WALKING FISH.

but without water; and, if it did not possess some special modification of structure, it would soon die.

This modification is to be found in a remarkable apparatus, called, in learned language, the "super-branchial organ," a term which I will explain as simply and briefly as possible.

It is composed, as too many scientific terms are, of one Latin word and one Greek word. In this case, the combination of the two signifies something that is over the gills. If the respiratory apparatus of any of these fishes be examined, it will be seen to be modified in rather a remarkable manner. The aperture of the gills is small and narrow, so that when the fish is out of the water, there is but little loss of moisture by evaporation. If the side of the head be opened, a supplementary apparatus will be found just above the gills, consisting of a number of very thin plates springing from one of the bony arches which support the gills. Between these plates a considerable amount of water is entangled, and serves to keep the gills moist while the fish is out of the water.

In fact, there is a remarkable analogy between the stomachs of the camel and the respiratory apparatus of the Climbing Perch. In both cases there are exceptional conditions which require an exceptional structure. In both cases the creature has to endure occasional deprivation of water; and in both cases it would die if it did not possess some means of retaining an amount of moisture sufficient to support life while it seeks for fresh supplies of water.

Now, the camel has, as all naturalists know, a stomach which is specially modified for the retention

of water, so that the animal can at one time take in enough water to serve it for three days, even in the dry sands and under the burning sun of the African desert. Thus provided, the camel is able to pass through the desert which no other animal could cross. The springs are very few, and some are several days' journey from each other; but the camel can cross the interval between them, sustained by the internal supply of water, which can be gradually introduced into the system as it is wanted. Here, again, is another analogy with the blood reservoir of the whales, which has already been described.

The water pools are to the Climbing Perch what the springs are to the camel; and so we have the remarkable fact that a fish is not only able to live out of water, but to travel over land. Nor is this all that it can do, for there is no doubt that the fish can not only travel on land, but can really climb trees. A report was current many years ago that it did possess this power; but it was thought to be one of the many popular but false notions about living creatures that had gradually fallen into disbelief.

It is now, however, certain that the Climbing Perch does ascend the trunks of the palm-trees, for the purpose of getting at the water which is generally found lodged at the junction of the leaves with the stem. In some species of palms this supply of water is so plentiful that the name of Traveller's Trees has been given to them. As long as any of these trees can be found, a traveller need not fear thirst, as all he has to do is to pierce the base of the leaf, and to hold a vessel to receive the water which pours from it.

The Climbing Perch would, therefore, find it no difficult matter to obtain the small quantity of water which is needful for filling its respiratory reservoir. From this remarkable habit, the fish has received the name of Paneiri, or Tree-climber.

The life led by these fish during the dry season, is very remarkable. They remain in their pools until they are so far dried up that nothing but a little mud is left at the bottom. They then find themselves obliged to migrate in search of water; and always choose the early morning for this purpose, so as to avoid the hot rays of the sun.

In these expeditions they can travel to great distances, and will pass over very rough ground. The worst part of their journey is always that which is nearest the pool. The cattle and wild animals come to drink, and, as the water is gradually dried up, they have to wade through the mud, into which their feet sink, leaving deep holes. The burning rays of the sun soon dry the mud, and bake it into a mass nearly as hard as brick; beside breaking it into wide and deep cracks. The fishes cannot avoid these cracks, and all that they can do is to make their way in and out of them.

Mr. Morris, who has supplied much useful information on this subject, calculates that in travelling sixty yards over this ground, the fishes had used sufficient muscular exertion to have taken them half a mile over level soil. Many of them lose their lives in these pits; not because they cannot climb out of them, but because the crows, hawks, and other birds pounce upon them while they are struggling to release themselves.

How they find their way to the water is not known. Their eyes being so close to the ground, they have but little range of vision; so that they cannot guide themselves by sight. Perhaps their sense of smell may have something to do with it; or they may possess a sense which is unknown to us, by which they are guided to the water.

This seems to be the case with the crustacea, as regards their food. If a number of shrimps and prawns are in a tank, and a tiny piece of meat be gently placed in the water and allowed to sink, the creatures take no notice for some little time. But if one of them happens to swim across the track of the meat, it becomes all life and animation; waves its antennæ here and there, like a dog hunting by scent, and then, having got on the track, follows it up, and seizes its food. A piece of shrimp or prawn will do just as well as any meat, the crustacea being terrible cannibals.

If the water were quite still, there would be little difficulty in understanding that the scent might be left in it. But at the Crystal Palace aquarium the water is perpetually driven through the tanks by a steam-engine, spirting into them with such force that the water is divided into a number of currents, crossing each other in all directions, as may be seen by the myriads of tiny air-bubbles which sparkle in it like those of newly-opened soda-water. Not a drop of water remains still for a second. The tiny column of water through which the piece of food passed, and in which its scent might have remained, was dispersed over the entire tank before it escaped at the outlet;

and yet the shrimps gave no sign until they came to the narrow track of their food. It is possible, therefore, that the Climbing Perch may be attracted to the water by a sense analogous to that which enables the crustacea to discover their prey.

The fishes can live for five or six days without a fresh supply of water, and so have plenty of time in which to make their migrations. When on shore they keep the gill-covers open, so that the oxygen of the atmosphere can play upon them, and they only need just enough of the water to keep them moist. The reader will remember that several of our own fish, such as the carp, can live for several days if kept in wet moss.

CRABS AS TRESPASSERS.

I suppose that there are few, if any, of my readers who have not seen living crabs and lobsters on the marble slab of a fishmonger's shop; and have, perhaps, when children, been quite astonished when they found that lobsters were not red until they were boiled.

Now these creatures had all been out of the sea for many hours, and were yet lively and strong, as anyone could testify who put his finger between their claws. How was it, then, that they were able to sustain life under such conditions, while fish which came from the sea at the same time were all dead? This is a very fair and reasonable question, and deserves a definite answer.

The reader will remember that the climbing

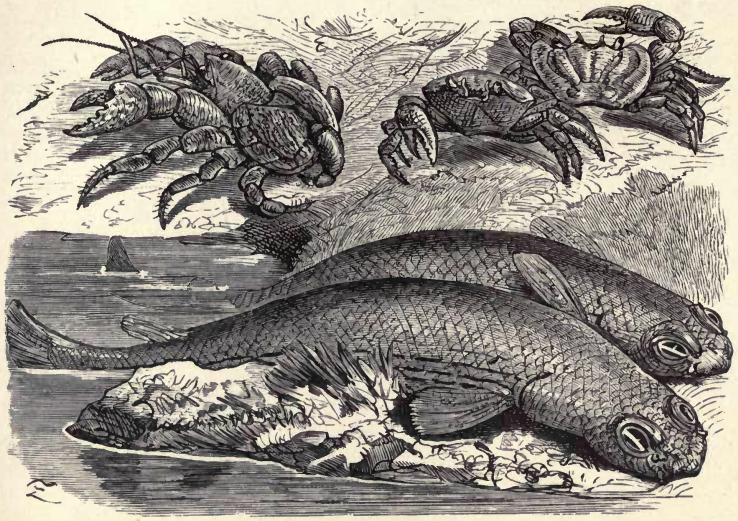
perch is able to sustain life while out of the water by an apparatus which keeps the gills moist, and enables them to perform their functions. A similar provision is to be found in the crabs and lobsters, although it is carried out in a different manner, which can be understood by any one who will take the trouble of opening a lobster.

When the shell of the "head," as it is called, is removed, there are seen on either side a number of whitish pointed objects, which go by the popular name of "lady's fingers," and are rejected as uneatable. If one of these fingers be removed and bent, it will be seen to consist of a vast number of delicate plates set very closely side by side. These are the gills or respiratory apparatus of the lobster; and, as long as they are kept moist, the creature can live.

Being protected as they are by that portion of the shell which encloses them, and is technically known as the carapace, there is but little evaporation; while their great comparative volume enables them to retain a considerable amount of water. Should they become at all dry, their moisture may be renewed by a short dip in the water, and the animal has another lease of life.

Not all the crustacea can thus endure a long absence from the water; but there are several species which can survive without water for many days; and there are some which live almost entirely on land, and only pay occasional visits to the water.

One of this species, the Robber Crab (*Birgus latro*), presents a curiously exact parallel to the climbing perch: not only being able to live for a considerable



CUT 16.—ROBBER CRAB, LAND CRAB, FOUR EYES.

time without water, but also possessing the ability to climb trees, which power it shares with others whose form seems less adapted for such a feat.

This Crab is found in the various islands of the Indian Ocean; and is a very odd-looking creature, appearing something like a compromise between a lobster, a crab, and a river cray-fish. It has very long and powerful legs, very large claws, and a very little abdomen.

It is almost as complete a trespasser as is the whale or the dolphin, for it passes almost the whole of its time upon land, and only visits the sea once in twenty-four hours, when it takes a dip, and then returns to its home. This home is essentially terrestrial, for it consists of a deep burrow excavated by the Crab, and in this retreat it passes the greater part of its time.

Most of the crustacea are carnivorous, as is seen in sea crabs, lobsters, and shrimps, which make short work of a drowned sailor if they can get at him. When a disfigured corpse is thrown ashore, the fishes generally have the credit of the defacement, but it is really due to the crabs, lobsters, and shrimps. The reader is perhaps aware that "shell fish," as they are called, which are supplied by our fishmongers, have been caught in traps which were baited with butcher's offal.

The Robber Crab, however, is vegetarian, and lives almost entirely on cocoa-nuts.

I have placed this Crab at the head of its kind because I think it to be the most extraordinary example of trespassing that can well be imagined. Let the

reader just imagine himself cast on a desert island with no tools, with nothing to eat but cocoa-nuts, and these on the top of a palm-tree which waves about in every breeze. I know that, under such circumstances, nine out of every ten men would starve to death.

Putting aside the difficulty of climbing the tree, even if a cocoa-nut happened to fall, they could not easily get at its contents. Cocoa-nuts, when fresh from the tree, are surrounded with a thick coating of hard, matted fibre, which bears about the same relation to the nut itself as the fruit of a peach does to its stone. A human being would find himself rather at a loss to get at the interior of a nut; and yet the Robber Crab can supply itself with nuts, and open them as easily as the attendant at a fishmonger's shop opens oysters.

Should no nut have fallen, the Crab can climb the tree and fling the nuts down, descending afterwards to feed on the banquet which it has provided for itself. It begins by inserting its claws into the outer coating, and tearing it away piecemeal. When it has thus extracted the nut from its covering, it sets to work at the task of opening it. Anyone who has seen a cocoa-nut is aware that at one end there are three circular spots, much softer than the shell of the nut, these being, in fact, the apertures through which the young palm plant springs when the nut is buried in the ground. One of these is much softer than the rest, and into it the Robber Crab fixes its claw. Holding the nut in this manner, the Crab bangs it against a stone, breaks the shell, and then feasts on the contents.

Nor is this all. In its burrow, the Crab requires a bed in order to be comfortable, and this bed it procures by taking the outer covering of the nut, tearing it into fibres, and carrying it in bundles into its burrow. The amount of this fibre which a single Crab will thus stow away is so great that the Malay sailors are in the habit of robbing them in order to obtain material for caulking the seams of their vessels.

As may be supposed from the strength which is needed in tearing up the outer cover of the nut and breaking the shell, the Robber Crab is a large species. When full grown it is about two feet in length, and when it walks it stands a full foot from the ground. The flesh of these Crabs is considered to be excellent.

The reader may probably be aware that there are many species of Crab which go under the collective name of "Land Crab," because, like the preceding species, they pass the greater part of their time on land, only visiting the water at intervals for the purpose of moistening the gills. Some of them are so remarkable for their speed when on shore, that they have gained the name of Racer Crabs. They can easily beat a man on foot, and to capture one of these creatures is a most difficult task, requiring the assistance of several persons, who drive it backwards and forwards until it is tired. Being gifted with this speed of limb, they think nothing of a long journey, and accordingly make their habitations at a considerable distance from the sea. In a favourable spot, the earth will be absolutely riddled with their burrows, even though the spot be several miles from the sea.

Sometimes the locality which is selected is not agreeable to the human inhabitants of the place. For example, in several parts of Ceylon, they have chosen to burrow in the public road, and have become absolute nuisances. They could not be extirpated, and, in consequence, a number of labourers were perpetually employed in filling up all the holes which the Land Crabs make.

Sometimes they had a grewsome way of choosing the cemeteries for their burrowing places. As the flesh of the Land Crab is considered a delicacy, the European residents are careful in ascertaining the dwelling-place of the Crabs which are brought to their tables. The negroes, however, are by no means fastidious, saying, with some justice, "Land Crab eat black man, black man eat he." For the Land Crabs follow the general custom of crustacea, and are carnivorous in their nature, eating anything in the way of animal substances that they can get, so that a dead negro affords a great feast for them.

These crabs are so completely acclimatized to the land, that even when they have to cast off their shells at the moulting season, they retire to their burrows for that purpose, block up the entrance, and remain there until the new shell has hardened.

Perhaps there are a few of my readers who are not acquainted with the curious crustacea called Hermit Crabs, or Soldier Crabs, which inhabit the shells of dead molluscs, and walk about with perfect ease, trailing their borrowed habitations behind them. They are very common along our coasts, and mostly inhabit

the shells of whelks or periwinkles. The dog whelk is a very favourite shell with them. They are forced to occupy this curious habitation, because they have the abdomen quite soft, and without any shelly covering, so that if they could not procure an artificial protection, they would be liable to great danger. In order to enable them to hold themselves firmly in their habitation, they are furnished with some claspers at the end of the tail.

The boatmen and fishermen of our coasts firmly believe that the Hermit Crabs are the young of lobsters, and no amount of reasoning can persuade them to the contrary.

In our country they never attain any great size, the whelk being the largest shell that they are likely to find. In the tropical seas, however, they grow to a very great size, and inhabit the shores in vast numbers. We shall see, from the following description by Mr. F. D. Bennett, in his "Whaling Voyage," that, like the Robber Crab, which has just been described, the great Hermit Crabs of the tropics possess the power of climbing trees. I may here add that the Robber Crab itself is allied to the Hermit Crabs, but as its tail is covered with shelly plates, like those of the ordinary lobster, it does not need any additional protection.

"The entire island is covered with Hermit Crabs, or Land Lobsters (*Cœnobati Sp.*), occupying the shells of *Turbo argyrostoma*. They bore a general resemblance to the largest species of *Pagurus* we found in the reef waters of the Society Isles, but different essentially from it in generic character, as well as in possessing terrestrial habits.

"The anterior and crustaceous portion of the animal (or that usually protruded from its tenement), is bright red, while the posterior and covered part of the body is flaccid, and of a yellow colour. The left forceps claw is larger than the right, though both are shorter than the first pair of legs; the eyes (ophthalmic peduncles) are long, and admirably adapted to afford a wide range of vision when the Cœnobita is closely retracted within the shell it inhabits.

"Their odour is peculiar and disagreeable.

"They were for the most part assembled in dense crowds, beneath bushes, or in shallow excavations at the roots of trees; though some of them, notwithstanding the cumbrous shells they carried, were clustered on the branches or in the crevices of trees. It was evident that, with the assistance of their forceps claws, they could climb a perpendicular height with great facility.

"It is a curious fact, that the most unique and elegant univalve sea shell in my collection was gathered from the branch of a tree, whither it had been conveyed by one of these creatures. When alarmed, they retreated, bearing their shells with them, but if touched, they shrank into the cavity of their dwellings and remained motionless. They sometimes, though very rarely, used their forceps in self-defence. When irritated, they produce a shrill croak, alternating with a rapid succession of sipping sounds.

"We preserved several of them alive for many weeks. They ate both animal and vegetable substance, as fish, land crabs, yams, and cocoa-nut. It was amusing to see them feed, nipping off, with much

nicety, a portion of the food with their forceps, and carrying it to their mouth, where it was received by the two small appendages in front of that organ.

"Night was their most busy time. When removed from their borrowed tenements, they easily regained them, and resumed their former position, while the vast number of empty shells strewn over the land indicated how frequently they changed their habitation during their progress to a mature growth."

In some places the shore is so covered with these Hermit Crabs, that when they are alarmed, and scuttle off for shelter, they make a great rattling as they bump their temporary house over the stones and among the empty shells which are strewn upon the shore.

In connection with the land-trespassing powers of the climbing perch and other fishes, it may here be mentioned that the Eels have great power, not only of existing on land, but of travelling over it. They wriggle themselves along with a sinuous movement like that of the serpent tribe, and can proceed for a considerable distance and with tolerable speed. They appear to prefer the early dawn for their migration, probably because the dew is still on the ground, and moistens the grass through which they thread their way.

The power of living out of the water is due to a modification of the breathing apparatus, which is identical in principle, if not in details of structure, to that which produces the same effect in the fishes and crustacea which we have lately examined. For the

Eel, indeed, such a structure is absolutely necessary, and that for the same reason which makes it useful in the climbing perch.

Although the Eels live much in rivers, they find a larger supply of food in ponds and ditches than in rivers; and accordingly, such places are generally well stocked with Eels. For example, not far from my house there is a little, muddy, narrow ditch, scarcely seven or eight feet wide, running parallel with the Thames, and only divided from it by the river wall. This ditch is a favourite resort for Eels, which find their way into it through the channels by which the ditch communicates with the river; and, being there, prefer their new quarters.

Such fortunate Eels as these would not need to migrate. Being able to exist in salt water as well as in fresh, they do not feel themselves discommoded by the sea water which flows into their ditches every tide. They have plenty of frogs and aquatic inhabitants for food; and, owing to its connection with the river, the ditch never runs dry.

But it is a different business when the Eel gets into ponds unconnected with springs, or into ditches that have no communication with rivers. In a time of lengthened drought they are sure to dry up, and then the Eels must perish, unless they could find some way of travelling to the water. Accordingly, the power of existing without water for a time is given to them by the modification of the breathing organs; while the means of transit is afforded by the sinuous movement of the snake-like body.

On Cut 17, two species of Eel are shown, the upper

CUT 17.—EELS AND CONGER.

figure representing the River Eel, and the lower, the marine Conger Eel. In the opinion of fishermen, the power of existing out of the water is anything but agreeable to them; for the Conger lashes so furiously with its tail, and snaps so fiercely with its powerful jaws, that if it be a large one, they are obliged to kill it before they dare to haul it on board.

Mention may also be made here of the curious little West Indian fishes called by the name of Four-Eyes, in which an adaptation of the organs of vision exists similar to that found in the Whirlwig beetle. When undisturbed, they seem to spend more of their time ashore than in the water, lying stranded on the shallow bank as shown in Cut 16. If alarmed, they scuttle into the water, returning in shoals to land as soon as the cause of their fear is removed.

PART II.

TRESPASSERS WITHIN THE EARTH.

We now come to the second division of this subject, namely, those creatures which pass most or a considerable portion of their time under the surface of the ground, and resort there for food or safety, or both. The actual proprietors of the dominion of Earth, we may take to be these annelids, of which the common

Earth-worm of the land, and the Lug-worm of the sea, may be accepted as typical examples.

The animal which at once suggests itself to the mind is that which not only shares the domain of earth with the worms, but feeds upon them, and therefore must be able to follow them wherever they go, namely, the common Mole. This animal has long been such a favourite of mine, and its life has always appeared to me to be so exceedingly wonderful, that I have already written much about it, and do not wish to repeat myself. I will therefore restrict myself entirely to the modifications of structure which enable it to trespass upon the domain of earth.

It is evident that the first requisite for an earth burrower is the possession of effective digging tools, and these are found in the two fore legs of the Mole. The hind legs are quite insignificant and feeble, all their strength seeming to have been lent to the front pair of limbs. In them, the bones are short, strong, and there is a supplementary bone at the shoulder, which affords attachment to the muscles used in digging, as well as giving a powerful leverage.

Then the shape and general structure of the fore paws, armed with their formidable nails, is worthy of notice, as producing a digging tool which is almost, if not quite, unrivalled. The muscular strength possessed by the Mole can hardly be estimated until the creature be taken in the hand.

This, however, is a dangerous experiment if the animal is to be kept alive; for it uses all its great power in its efforts to escape; the strong muscles being plainly felt as they work under the skin, and

the creature can hardly be detained without holding it tightly. This, however, is sure to kill the Mole, which is curiously sensitive to a grasp round the waist; and, although no signs of injury can be detected, the animal is sure to die before many hours have elapsed. It is a strangely delicate animal; and, in spite of the ferocity, and even the fury of its disposition, seems to have but little hold on life.

Only a few days before writing this account, a professional mole-catcher brought me a fine specimen. Not having by me a large box or tub in which I could put some earth, I placed the animal in a box which had been filled with specimens of auriferous quartz from Brazil. Some of the dust was still left in the corners, and this appeared to be fatal to the Mole, which ran about with great fussiness, poking its long, mobile muzzle into each corner, and seeming to be quite distressed at the dust.

Its movements became perceptibly slower; and before an hour had elapsed, the Mole was dead. It would not even touch one of the worms for which I sent the gardener as soon as it arrived; and, from that unwonted abstinence, I augured bad things; the Mole generally flying at a worm as if it were mad.

By what sense the animal is able to trace its prey, or how it can manage to find its way through the innumerable tunnels which it drives, at all kinds of levels, are two problems which have hitherto remained unsolved. Anyone who has seen a worm jerk itself into its hole, can appreciate the quickness with which it can pass through its narrow tunnel; and it certainly is a mystery to me how the Mole can manage to

capture the worms. These annelids are slow movers on the surface of the earth; but in their holes they move like lightning, being aided by the stiff, bristly hairs that project from the many rings of which the body is composed, and which are set against the sides of the tunnel.

When, for example, the worms come to the surface, they do not leave their holes entirely, but always keep the end of the tail within the hole, stretching the body as far as possible in all directions. If under these circumstances they are alarmed, they spring back with such rapidity, that the eye can scarcely follow the movement. That there is some sort of a pursuing on the part of the Mole, and flight on that of the worm, is, I think, obvious from the fact that whenever the earth is agitated, either by stamping on it, or by driving a spade into the ground and moving it backwards and forwards, the worms come to the surface, evidently in flight from their enemy the Mole. The reader will see, therefore, how difficult must be the task of the Mole. And this difficulty is increased when we reflect upon the furiously raging appetite of the Mole, and the great number of worms which it devours in the course of a day.

The next point is its ability of finding its way through the maze of dark tunnels which it constructs. Even if they were not dark, there would be no means of distinguishing one from the other, all being exactly alike. I suppose that the action of gravity tells the Mole the way to the upper earth; but I have not the least idea how it can find its way to the elaborate subterranean fortress which it constructs under the

CUT 18.—MOLE AND SLEPEZ.

roots of some tree or bush, and from which its tunnels radiate in all directions.

A figure of the Mole is given on Cut 18.

That the title of blind is often applied, though wrongly, to the Mole, is familiarly known. That animal, however, does possess a pair of veritable eyes, very tiny, but still eyes, may be seen by blowing away the fur.

But in the Slepez, sometimes called the Mole Rat (*Spalax typhlus*), the external eyes are absolutely wanting, being represented by a couple of little black specks under the skin. The Slepez, like the Mole, passes a subterranean life, and seems never to come to the surface of the earth except to bask in the sun. Even in that case, it imitates the worm in remaining close to its burrow, into which it plunges at the least alarm.

There is one great distinction between the Mole and the Slepez. The food of the former is wholly of an animal nature; while that of the latter is, as far as is known, wholly of a vegetable nature. As the Mole feeds upon the worms which it captures under ground, so does the Slepez feed upon the roots of plants; both animals procuring their food without showing themselves above the surface of the ground. Whether or not the Slepez can be reckoned as beautiful, is a mooted point. That the Mole is one of the most useful wild animals in our country is now recognized; inasmuch as it does not damage the crops; and it renders inestimable service in admitting air and rain into the earth, as well as bringing fresh soil from below, and placing it on the surface, where it acts as

a "top-dressing." In these latter respects the two animals are tolerably equal; but it may be said against the Slepez, that the good which it does in removing the soil is counterbalanced by the harm which it does in devouring the roots.

There is a very remarkable animal which was, I believe, discovered by the late Mr. J. K. Lord in British Columbia, or, at all events, he was the first to notice its habits. It is an insectivorous mammal, about as large as an ordinary shrew-mouse. Like the Slepez, it has no eyes, and apparently possesses but little sense of hearing, all sensation seeming to be comprised in its nose. This again is very much elongated, and, according to Mr. Lord, "is terminated in a naked, fleshy kind of a bulb gland, and this gland is pierced by two minute holes, which are the nostrils. Each nostril has a little fold of membrane hanging down over it like a shutter, effectually preventing sand and minute particles of dust from getting into the nose while digging. It belongs to the genus Urotrichus.

This animal has a central house something like that of the mole, and from that it cuts a number of radiating tunnels, having frequent openings into the air. Mr. Lord is of opinion that these tunnels are simply used as roadways, not as means of obtaining food.

Mr. Lord's account of the habits of this animal is so graphic that I cannot resist the temptation of transferring a portion of it to these pages, for a better description of the life of an earth trespasser can hardly be found.

"As he digs out the tunnel with his trowel hands,

he throws back the earth towards his hind feet. These, from their peculiar shape, enable him to back this dirt out of the hole, using them like two scrapers, only that he pushes the dirt away instead of pulling it towards himself. Having backed the dirt clear of the mouth of the hole, he throws it out over the edge of the open cutting. After having dug some distance, and finding, I dare say, the labour of backing out rather irksome, he digs up through the ground to the surface, makes another open cutting, and then begins a new hole or tunnel, and disappears into the earth again. When he has gone as far from his dormitory as he deems wise, he again digs through, and clears away the rubbish. This road is now complete, so he goes back again to his central mansion, to begin others at his leisure.

"He is a night-feeder, and exposed to terrible dangers from the various small carnivora that prowl about like bandits in the dark—stoats, weasels, martens, and skunks. So to avoid and escape these enemies, he comes quietly along the subterranean roadways, and cautiously emerging at the open cutting, feels about with his wonderful nose; and, I doubt not, guided by a sense of smell, pounces upon larvæ, slugs, beetles, or any nocturnal creeping thing he can catch; and so traversing his different hunting trails during the night, manages in that way to fare sumptuously and safe from danger.

"It is scarcely possible to imagine a more skilfully contrived hunting system, to avoid danger and facilitate escape, than are these tunnel trails with open cuttings. For the shy little hunter has, on the slightest

alarm, two means of flight at his disposal, one before and another behind him, and the fur, lying as evenly when smoothed from tail to head as it does when turned in the natural direction, enables him to turn astern, and retreat, tail first, into his hole, as easily as he would go head first.

"When we contemplate this grotesque and strangely formed little creature, and see how wisely and wonderfully it is fashioned and adapted to its destined place, supplying another link in the great chain of Nature, we cannot but feel God's power and omnipresence.

"Feeding in the dark, and living in the dark, eyes would have been superfluous. Sound, save from vibration in the earth, or when hunting at the open cuttings, would seldom reach the tiny hermits. Hence, the hearing organs have no external appendage for catching sounds, and are but in a rudimentary form.

"Hands fashioned with marvellous digging tools, and hind feet turned into scrapers, for getting rid of the rubbish dug out with the hands; nose possessing smell and touch in their most exquisite forces;—these serve him for guides of unerring certainty and undeviating precision through his darksome wanderings."

There are many other earth-trespassing animals which I should well like to describe, but must omit, on account of our fast-waning space. I cannot, however, but mention that extraordinary little being, the Pichiciago of Chili (*Chlamyphorus truncatus*), which is at the same time one of the rarest and the most curious of the mammalia.

It is a little bit of a creature, only a few inches in length, and possessing a suit of shelly armour much like that of the armadillo, except that the hind quarters are also covered with shelly plates. Beneath the shell, if we may so call it, there is a coating of shining yellow hair, looking very much like floss silk.

There are two points about this remarkable animal which are worthy of notice, the one being the mode in which the hind quarters are protected, and the other the manner in which the shelly covering is affixed to the body.

As to the first point, there is a curious and very striking analogy between the armour of the Pichiciago and the shell of the testacella slug. This creature feeds on worms, which it follows down their holes, and in order to be protected from any foe that might follow it in the rear, it has a small shell on the end of its tail. This shell prevents the slug from being assailed from behind, and is clearly analogous to the armour of the Pichiciago.

The next point is the mode of affixing the shelly plates. In most mammals which possess similar armour, such as the armadillo, the manis, etc., the armour is a mere growth from the skin, and can be removed with the skin. But in the Pichiciago, we have the remarkable fact that the framework which supports the horny armour is attached to the skeleton, as may be seen by examining the specimen to be seen in the British Museum.

As to the partial earth trespassers among the mammalia, they are far too many to be described, or even enumerated. I will therefore merely content

myself with mentioning a few which are inhabitants of our country, and which are represented on Plate VI.

On the upper part of the plate is shown the common Badger, which was once so plentiful in England, and is now so rare, the progress of agriculture having driven it from so many spots where once it dwelt in safety.

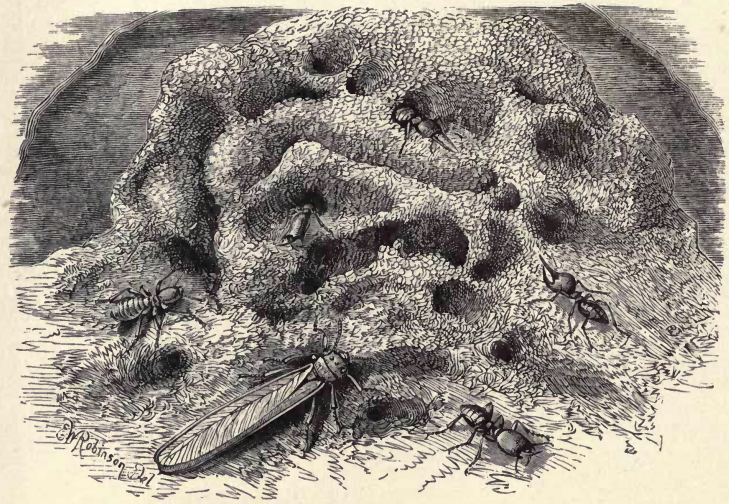
Next comes the Fox, another of the partial earth trespassers. Like the Badger, the Fox remains in its tunnel, or "earth," as it is popularly called, during the day, and only issues forth at night for the purpose of procuring food.

Then there are the Rabbits, which, as far as earth trespassing goes, have many of the habits of the badger and the fox, except that their food is of a vegetable and not an animal nature.

Although they are not so strictly nocturnal as the two preceding animals, they always prefer the very early morning or the evening dusk for issuing from their burrows. I scarcely know a prettier sight than that of the Rabbits somewhere about sunrise on a summer's day. They are not accustomed to be disturbed at that time, and, in consequence, play about with a freedom which they scarcely ever assume at any other time of day.

Lastly, we have the Field Mice, which are by no means nocturnal, like their fellows the house mice, but boldly leave their burrows and search for food in broad day, trusting to the manner in which their hues blend with those of the ground, the resemblance being so perfect that scarcely any eye but that of the kestrel can detect them.

FOX, BADGER, RABBIT, AND FIELD MOUSE.



CUT 19.—TERMITES.

I shall end this work with brief descriptions of two remarkable earth trespassers among the insects, both of which are popularly called Ants, though they are as far apart as are the cat and the rabbit.

Yet, diverse as they are in the scale of creation, their resemblance to each other, both in appearance and habits, is extraordinarily close. I have now before me a box full of Termites and Travelling Ants, and I am quite sure that no one who was not a practical entomologist could distinguish between the Termites and the Ants. In both there are the remarkable gradations of soldier and labourer; in both there is the dislike to light; and in both there is the habit of constructing for themselves habitations which shall keep from them the unwelcome rays of the sun.

We will first take the Termites.

The illustration on Cut 19 represents a portion of the nest laid open, and is drawn from a specimen in the British Museum.

I have not space to relate the whole of the wonderful life led by the various species of Termite, inasmuch as the whole of the present volume would not suffice for such a biography. Suffice it to say that all the Termites have the strongest objection to light, and that they have various ways of protecting themselves from it. Some of them build galleries for themselves, while some are content to burrow into wood and similar substances, sometimes even boring into trees, and eating out the whole of the interior, and leaving nothing but a thin shell.

As an example of the manner in which the Ter-

mites will burrow into a tree until it is nothing but a shell, I may mention an adventure which befel Mr. E. Sullivan, and which is related by him in his work, "The Bungalow and the Tent."

He had disturbed an elephant, which charged fiercely, and very nearly caught him. At last he saw a fairly sized tree, from which hung a "bush-

CUT XX.—TRAVELLING ANTS.

rope," one of the creeping plants of which the jungle is so full. He sprung at the rope, ascended about twenty feet, and had the satisfaction of seeing the elephant pass beneath him and lose the track.

"It was not until I had descended from my retreat that I was aware of the actual danger I had escaped. The tree was entirely hollowed out and consumed by

the White Ant, and nothing but the shell remained. Had I been a stone or two heavier, it is probable it would not have borne me, and as it was, if the elephant had seen me and pulled at the tree, it would have crumbled down like so much paper."

It has often happened that travellers have casually snapped a branch of a tree, and have been very much surprised at being covered with Termites which have issued from it.

Now as to the Travelling Ants, which are shown in the illustration. These creatures act, when on the march, just as do soldiers when pushing their way towards a battery. They always keep themselves under cover, and in a most extraordinary manner, and with wonderful speed, build covered galleries, under the shelter of which they can proceed unmolested by the unwelcome light.

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